January 4, 1960

Aviation Week

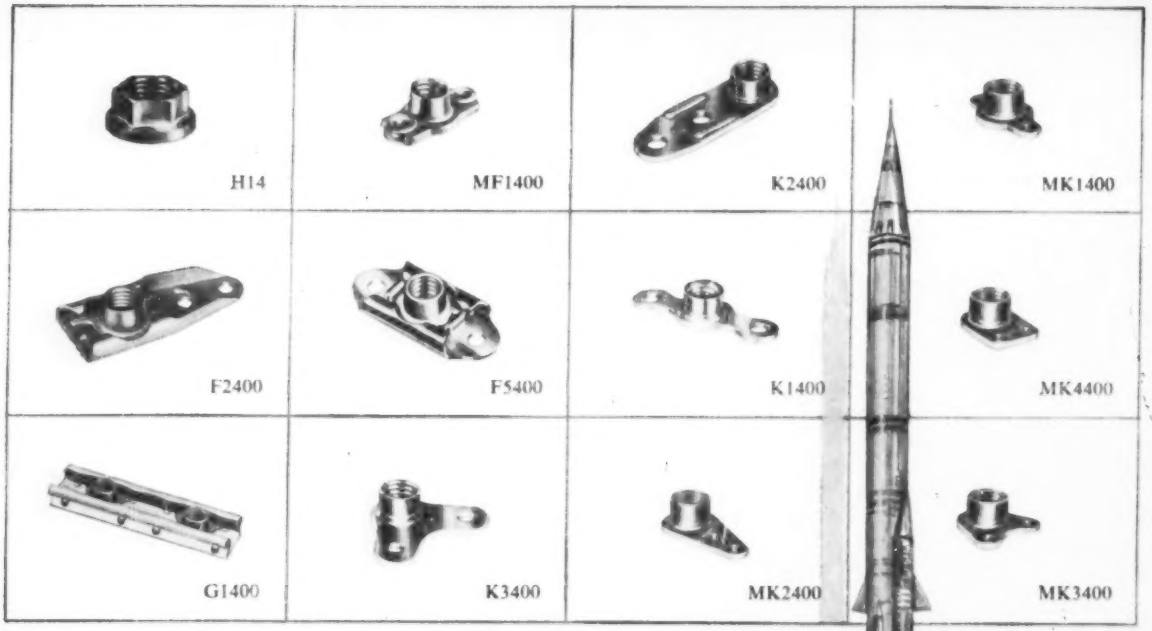
Including Space Technology

A McGraw-Hill Publication

Tunnel Simulates Rocket Problems At High Altitude

Boeing 720 Medium Range Transport

Fabrication Advances Speed Atlas Production



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Jan. 11-13—Sixth National Symposium on Reliability and Quality Control in Electronics, Statler-Hilton Hotel, Washington, D. C.

Jan. 11-13 "Lectures in Aerospace Medicine," U. S. A. F. Aerospace Medical Center, Brooks AFB, Tex.

Jan. 11-15—1960 Annual Meeting, Society of Automotive Engineers, Sheraton-Cadillac and Statler Hotels, Detroit, Mich.

Jan. 12-16—16th Annual Technical Conference, Society of Plastics Engineers, Conrad Hilton Hotel, Chicago, Ill.

Jan. 18-20—12th Annual Convention, Helicopter Assn. of America, Disneyland Hotel, Anaheim, Calif.

Jan. 18-21—Sixth Annual Meeting, American Astronautical Society, Statler-Hilton Hotel, New York, N. Y.

Jan. 18-Feb. 5—Aviation Institute for Business Pilots and Commercial Carriers, University of Southern California, Los Angeles, Calif.

Jan. 20-21—Board of Directors Meeting, Airport Operators Council, Statler Hotel, Washington, D. C.

Jan. 20-22—Capitalizing on Technology, Special Research and Development Conference, American Management Assn., Roosevelt Hotel, New York, N. Y.

Jan. 25-26—Annual Meeting, Association of Local Transport Airlines, National Aviation Club, Washington, D. C.

Jan. 25-28—28th Annual Meeting, Institute of the Aeronautical Sciences, Hotel Astor, New York, N. Y. Honors Night Dinner, Jan. 26.

Jan. 28-29—Solid Propellants Conference, American Rocket Society, Princeton University, Princeton, N. J.

Feb. 1-4—Winter Conference & Exhibit, Instrument Society of America, Rice Hotel and Sam Houston Coliseum, Houston.

Feb. 2-4—15th Annual Reinforced Plastics Division Conference, Society of the

(Continued on page 6)

AVIATION WEEK Including Space Technology

January 4, 1960

Vol. 72, No. 1

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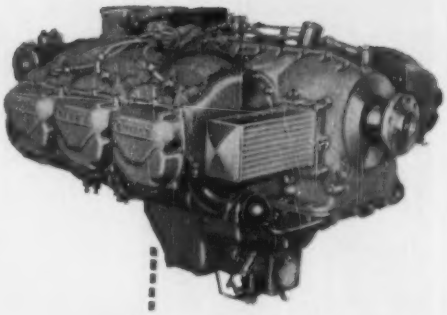

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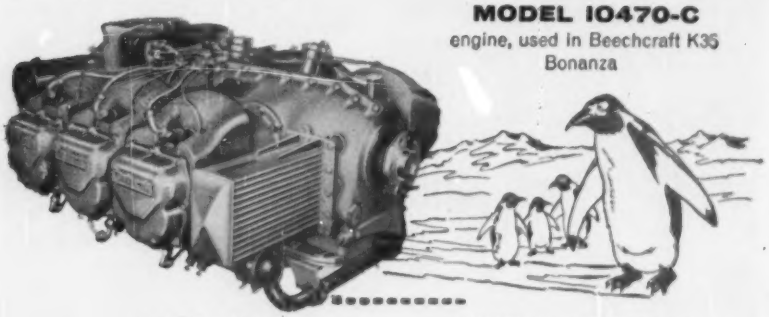

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AVIATION CALENDAR

(Continued from page 5)

Plastics Industry, Edgewater Beach Hotel, Chicago, Ill.

Feb. 3-4—Sixth Annual Midwest Welding Conference, Illinois Tech Chemistry Bldg., Chicago, Ill. Sponsors: Armour Research Foundation of Illinois Institute of Technology; Chicago Section, American Welding Society.

Feb. 3-5—1960 Winter Convention on Military Electronics, Institute of Radio Engineers, Biltmore Hotel, Los Angeles.

Feb. 10-12—Seventh Annual Solid-State Circuits Conference, Philadelphia, Pa. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; University of Pennsylvania.

Feb. 16-18—First National Symposium on Nondestructive Testing of Aircraft and Missile Components, Hilton Hotel, San Antonio, Tex. Sponsors: Southwest Section, Society for Nondestructive Testing; Southwest Research Institute.

Feb. 24-26—Fourth Annual Meeting, Biophysical Society, Sheraton Hotel, Philadelphia, Pa.

Mar. 9-11—Conference on the Mechanical Properties of Engineering Ceramics, North Carolina State College, Raleigh, N. C. Sponsors: North Carolina State College School of Engineering; Office of Ordnance Research, U. S. Army.

Mar. 10-11—National Flight Propulsion Meeting (classified), Institute of the Aeronautical Sciences, Cleveland, Ohio.

Mar. 23-25—Symposium on Optical Spectrometric Measurement of High Temperatures, University of Chicago, Chicago, Ill. Sponsors: University of Chicago's Applied Science Laboratories; Jarrell-Ash Co.; National Science Foundation.

Apr. 6-8—Structural Design of Space Vehicles Conference, Biltmore Hotel, Santa Barbara, Calif. Sponsor: American Rocket Society's Structures and Materials Committee.

Apr. 6-8—1960 National Meeting "Hyper-Environments-Space Frontier," Institute of Environmental Sciences, Biltmore Hotel, Los Angeles, Calif.

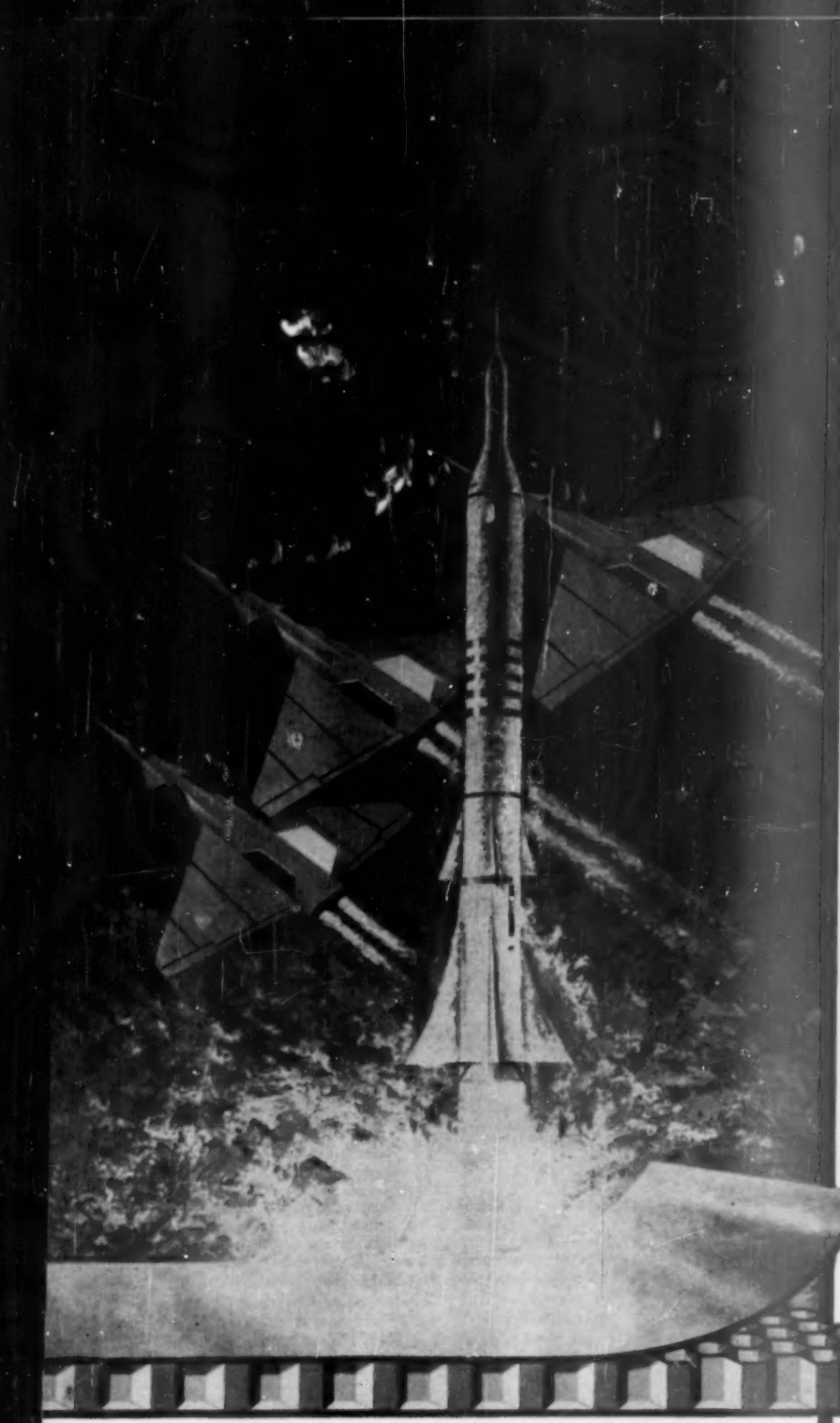
Apr. 19-21—International Symposium on Active Networks and Feedback Systems, Engineering Societies Bldg., New York, N. Y. Sponsors: Polytechnic Institute of Brooklyn; Department of Defense Research Agencies; Institute of Radio Engineers.

Apr. 20-22 — National Symposium on Manned Space Stations, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif. Cosponsors: NASA; the Rand Corp.

Apr. 21-22—Southwest Metals & Minerals Conference "Metals and Materials for the Space Age," American Institute of Mining, Metallurgical and Petroleum Engineers, Ambassador Hotel, Los Angeles.

Apr. 25-29—41st Annual Convention and Exposition, American Welding Society, Biltmore Hotel and Great Western Exhibit Center, Los Angeles, Calif.

Apr. 27-28—National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton Gibson Hotel, Cincinnati, Ohio.



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LG-68

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January 4, 1960

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Including Space Technology

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COVER: Boeing 720 medium-range turbojet transport, the first of 18 ordered by United Air Lines, is in the flight test phase of its development program. Powerplants are four Pratt & Whitney JT3C-7 turbojet engines. Maximum cruise speed is approximately 615 mph. For other photos of the 720 in flight, see pp. 36-37.

PICTURE CREDITS

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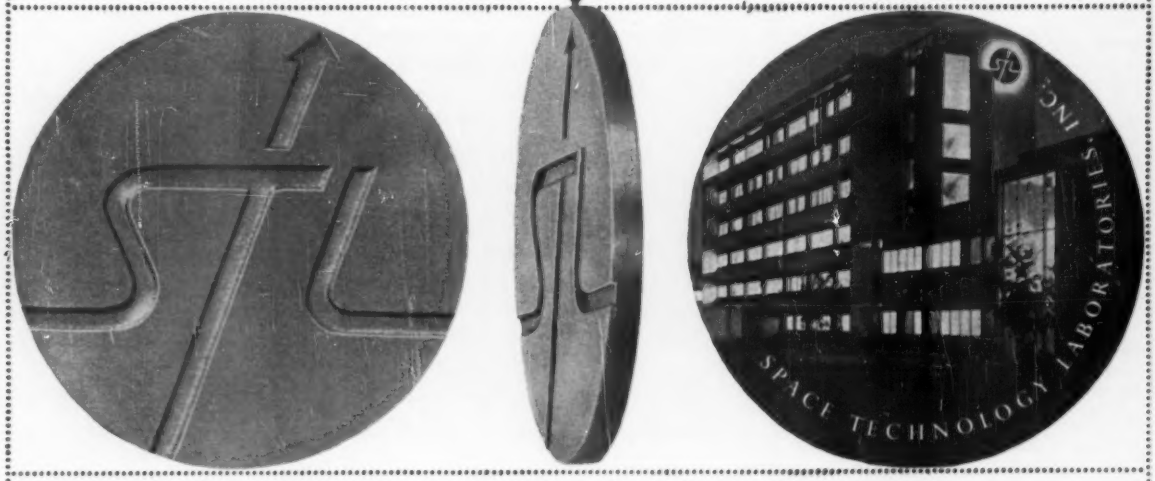
SCIENTISTS AND ENGINEERS: There are two sides to the STL coin...



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SPACE TECHNOLOGY LABORATORIES, INC.

EDITORIAL

Beginning a New Decade

The year we are beginning is not only another chapter in the always hectic history of aviation and its related technologies but may well represent the beginning of a new volume entitled "Decade of Decision." It is obvious now, with the always useful advantage of hindsight, that the decade just ended has been dominated by the steady growth of the Communist challenge. From the bloody Korean war that opened the decade to the Berlin crisis of 1959, the history of this period has been characterized by Communist aggression radiating from the twin antennae of Moscow and Peking and the Western world's attempts to halt and repel it.

There are many indications that the decade just beginning may see this basic struggle enter a decisive phase that could indicate which of these diametrically opposed philosophies will permeate the world. Regardless of the other issues that may pop into temporary prominence, this major conflict between communism and the free world will be the dominant issue of this decade and the principal influence on the aviation industry and its related technologies.

For the short-term outlook for 1960, it appears that this national election year will see little in the way of fundamental policy change. But, in the presidential campaign next fall, many of the basic guidelines that will guide future political administrations may crystallize. It is unlikely that the elderly conservatism of the current Administration will offer much prospect of success to the candidates of either party in the 1960 election and, without the tremendous personal prestige available to President Eisenhower, the campaign is likely to be dominated more by issues than by personalities. Meanwhile, the aviation industry and its related technologies will have to struggle along with precious little government attention to its pressing problems except as they become political issues. Even then, the outlook for 1960 is for talk, not action.

New Environments

Aside from the heavy political overtones, both domestic and international, that promise to add new flavor to this decade, the industry finds itself also embarking into new technical and economic environments that will basically change its character and policies.

In the airline field, the 1960s will bring the first full impact of the jet age and confront airline managements with the blunt facts of its operational and economic problems. The speed and certainty with which individual airline managements react to these new problems will certainly account for many radical shifts in the position of their firms within the field, and the prospects for serious crises appear inevitable for more than one airline during 1960. In coping with these problems, the airlines will need a swiftly responsive and thoughtfully understanding support from the Federal Aviation Agency and the Civil Aeronautics Board.

In the military field, the twin technologies of long range ballistic missiles and exploration of space will certainly dominate the technology of this decade, although the problem of integrating them effectively with the manned vehicle both in the atmosphere and outer space will continue to be of considerable importance. This period is likely to see a continued emphasis on research and development as the major occupation of the defense business, with the problem of balancing the technical pace against the requirements of an effective force in-being continuing as a vexing issue that will hardly be solved to the satisfaction of any of the contending military, political or economic forces involved. Both industry managements and government executives and legislators will find considerable difficulty in adjusting their thinking and operational techniques to these new problems within a sufficiently short timespan to be truly effective.

Fundamental Revisions Vital

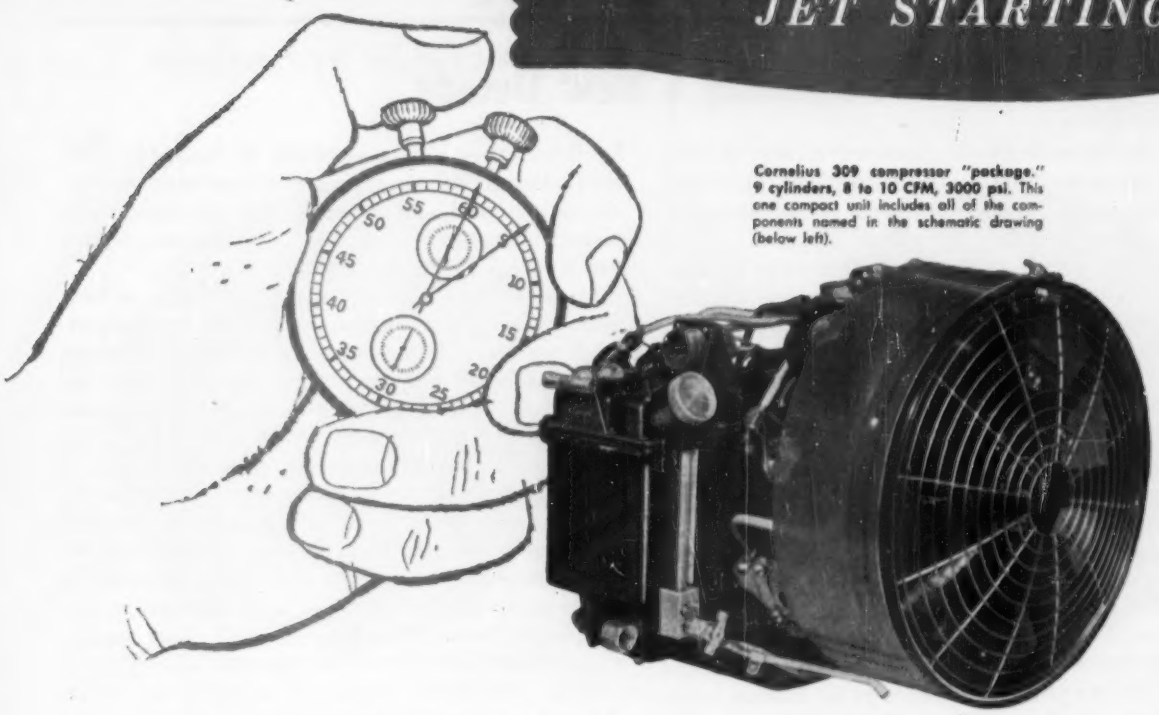
Some fundamental revision in basic military strategy and its relation to political programs and the international economy appear to be a vital requirement for the 1960s. Some observers would define the strategic need as that of organizing an effective basic strategy for the United States position in this decade since they believe there is no such over-all strategic plan now in existence.

The area of space technology is certain to be an issue in the 1960 presidential election, although of exactly what magnitude is currently open to debate. The impact and significance of space exploration either as a scientific endeavor or as an international prestige yardstick has been consistently underplayed to the American people by the White House and its carefully selected "tame" scientific advisors. Consequently, there is a corresponding lack of intensity in the general public's interest in this problem which may be alleviated by younger and more vigorous political leadership that appears certain to emerge from the 1960 election regardless of which party is victorious.

While the space issue may not be the most important issue of the early 1960s, how this country tackles it may well be symptomatic of how well it will handle the many other and perhaps more significant problems in the technical-economic-political trinity that is involved in our development of a successful formula to repel and dissolve the challenge of international communism.—**Robert Hotz**

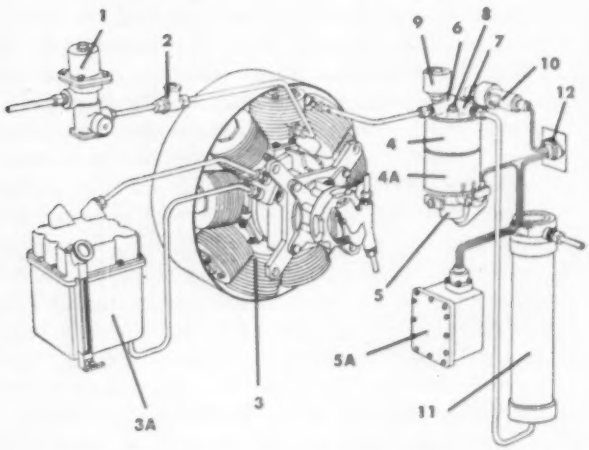
. . . important news about

JET STARTING



Cornelius 309 compressor "package." 9 cylinders, 8 to 10 CFM, 3000 psi. This one compact unit includes all of the components named in the schematic drawing (below left).

for reliable "split-second" jet starting equip your jets with Cornelius compressors



1. Absolute Pressure Regulator 2. Vacuum Breaker 3. Air Compressor with Hydraulic or Electric Motor 3A. Oil Reservoir 4. Moisture Separator 4A. Thermostatically Controlled Heater Blanket 5. Condensate Dump Valve 5A. Condensate Exhaust Timer and Relay 6. Check Valve 7. Back Pressure Valve 8. Switch Rupture Disc 9. System Relief Valve 10. Pressure Switch 11. Chemical Drier 12. AC-DC Power Input

The Cornelius 309 compressor "package" will soon be operational on five major domestic airlines and five major foreign airlines. It has also been selected for installation on the Allison Prop-Jet Super Convair. This pneumatic system was developed to give jets better, faster starts. It is unmatched for reliability, capacity and longer life. It improves the performance of any jet or prop-jet equipped with a fuel-air starting system.

Here are some facts that demonstrate Cornelius equipment superiority: The 309 compressor is the largest capacity compressor now in production and flying. Its 8 to 10 CFM air delivery is 50 per cent greater than any other available compressor. This larger CFM delivery means greater reliability and longer life because less "ON" time is required for air reservoir recovery; is ideal for short flights.

Specify Cornelius as original equipment. Whether you are an airline or an airframe manufacturer, you are guaranteed to receive a compressor package that is the last word in design and performance — a compressor *second-to-none.*

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Pioneers in pneumatic systems for aircraft.

WHO'S WHERE

In the Front Office

Michael G. Kagan, president, Pioneer Parachute Co., Manchester, Conn., a subsidiary of Reliance Manufacturing Co., succeeding **Lyman Ford**, retiring. Also: **William Bell**, executive vice president.

Henry Knippenberg, president and general manager, Dresser-Ideco Co., Columbus, Ohio, succeeding **John L. Pausch**, now chairman.

G. W. Rutherford, a vice president, Ryan Aeronautical Co., San Diego, Calif. Mr. Rutherford is manager of Ryan's Electronics Division.

Dr. Harold W. Ritchey, vice president in charge of the Rocket Divisions of Thiokol Chemical Corp., Bristol, Pa. Also: **Dr. Ritchey**, and **Joseph S. Jorczak**, vice president in charge of the Specialties Division, appointed directors of Thiokol.

H. Joseph Chase, vice president and general manager, Aviation Division, Radio Corp. of America, New York, N. Y. Also: **Leonard S. Holstad**, vice president, Electronic Data Processing Service, RCA Service Co.

Dr. Leland G. Cole, vice president-research, Beckman Instruments, Inc., Fullerton, Calif.

Walter J. Merck, executive vice president-operation, Hitemp Wires, Inc., Westbury, N. Y.

Boeing Airplane Co.'s eastern representative, **Vice President James P. Murray**, has retired but will continue as a vice president and an adviser to the company's management. **Clifford E. Roberts** is now manager-Washington office.

Raymond G. Johnson, a vice president, General Precision Laboratory, Inc., Pleasantville, N. Y., a GPE subsidiary.

Curtis A. Haines, vice president-facilities and manufacturing planning, Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc., Waltham, Mass.

Dr. Maurice Nelles, vice president-engineering, American Electronics, Inc., Los Angeles, Calif.

Guy M. Springer, Jr., vice president, Air Cargo, Inc., Washington, D. C.

James B. Williams, vice president-engineering, Electronic Communications, Inc., St. Petersburg, Fla.

Dorothy P. Vogel, vice president and general manager, Colvin Laboratories, Inc., East Orange, N. J.

Honors and Elections

William P. MacCracken, Jr., a pioneer in aviation legislation, has been awarded the Wright Brothers Memorial Trophy for 1959 by the National Aeronautics Assn.

Jack Leonard, military requirements manager of Cessna Aircraft Co.'s Military Division, has been elected chairman of the Helicopter Council of the Aerospace Industries Assn.

James M. Reilly, staff manager-telecommunications of American Airlines, has been elected chairman of the Interline Communications Committee of the Air Transport Assn. of America.

(*Continued on page 91*)

INDUSTRY OBSERVER

► Estimated total order for Agena B space vehicle upper stages (AW Dec. 21, p. 18) is 70, with National Aeronautics and Space Administration expected to order less than a dozen, at least initially. Others will be used by the Air Force in the WS-117L military satellite program and other space missions.

► **USAF-Hughes Aircraft Co.'s GAR-9 air-to-air missile, which will have a range in excess of 200 mi., will be 14 to 15 ft. long, 14 to 15 in. in diameter. These dimensions are basically equivalent to those of the Bendix Eagle air-to-air missile under development for Navy.**

► Proposals under a Navy Bureau of Weapons competition for a subsonic missileer carrier-based aircraft, which probably will carry six Eagle air-to-air interceptor missiles, are due Feb. 29. Bids probably will be submitted by at least eight companies, including Douglas, Chance Vought, Grumman, McDonnell, Boeing-Wichita, Bell, Convair and North American. Navy has not established detailed specifications, is leaving it to industry to propose the best solutions to the problems at hand. Limit of 50,000 lb. gross is generally applicable, and turboprop and fan-type turbojet powerplants are favored. Modified existing aircraft which may be considered include the Grumman A2F, whose rollout is scheduled for next spring, the Grumman W2F and the Douglas A3D.

► **Air Force is considering awarding a contract for an analysis of Atlas ICBM blast effects plus redesign of the launch silo for the missile at Lincoln AFB.**

► Project Skybolt is Air Force's new designation for Weapon System 138-A which includes the GAM-87A air-launched ballistic missile. Defense Department decision on whether to proceed with the ALBM development at Douglas, expected in the next 30-60 days, is awaiting results of USAF-Douglas study made at Defense's request to determine whether a missile with sufficient accuracy can become operational before manned bombers become obsolescent (AW Nov. 9, p. 30).

► **Selection of a prime contractor in a competition to implement and operate Army's Electronic Environmental Test Facility at Ft. Huachuca, Ariz., is scheduled to be made this month from the four final contenders—Cook Electric Co., Pan American World Airways, Sylvania Electric Products Co. and the Vitro Corp. Army is now negotiating with the four on the aspects of cost and fees before making its decision. One of the prime functions of the facility will be to determine how advanced electronic equipment will operate under battle environments. Present planning for the program covers a three-year period, for which the initial funding allocation will be about $10 million.**

► General Precision Laboratory, Inc., is reportedly a leading contender for an optical communications contract expected to be awarded shortly by the Rome Air Development Center (AW Dec. 14, p. 87). Contract involves study of the suitability of visible and ultraviolet regions for communications. Another contract for a communications system in the middle and near infrared regions is scheduled to be awarded by Wright Air Development Center this month. An earlier award, covering the study of modulation techniques of solar light, went to Electro-Optical Systems, Inc.

► **Beech Aircraft, in a move to expand its lower-priced line, plans to market two new aircraft in the $14,000 and $16,500 price categories. In a related move, Beech also plans to increase its dealerships and unit sales. The company, which now has about 60 dealers, expects to double this number during early 1960. Beech also notes that about 48% of all dollars spent on executive aircraft run to those listing at less than $20,000. The new four-place standard Beech Model 33 Debonair (AW Sept. 28, p. 126) lists for $19,995.**

► Air Force is canceling construction of two hard silo launchers for the Atlas ICBM that had been scheduled for Vandenberg AFB, Calif.

► **Air Research and Development Command has acquired a vessel costing approximately $100,000 which it formerly operated under lease for use as a missile and satellite tracking station in Caribbean waters. Stanford Research Institute personnel will man the vessel's electronics gear.**

UNITED AIR LINES SELECTS BENDIX DOPPLER NAVIGATION

When it starts service between California and Hawaii early in 1960, United Air Lines' new DC-8 Jet Mainliner fleet will be equipped with Bendix* DRA-12 Doppler Radar. This new navigation system provides complete ground speed and course deviation data continuously and automatically without dependence on ground facilities.

*REG. U. S. PAT. OFF.

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Washington Roundup

Congressional Outlook

Congress, which convenes on Wednesday, is expected to plunge into a short but active session as soon as it receives the President's Fiscal 1961 budget detailing the Administration's programs and the funds earmarked to finance them—probably on Jan. 18. The goal is to adjourn before July 11, date of the Democratic national convention.

Reports in the early days of the session—which will be the basis for later action—will cover:

• **Management and effectiveness of Air Force's** ballistic missile program will be reviewed by the General Accounting Office, the watchdog agency of Congress. At least a half dozen committees are anxiously awaiting this report, including the House Appropriations Subcommittee on the Armed Services headed by Rep. George Mahon (D.-Tex.); the House Armed Services Investigating Subcommittee headed by Rep. Edward Hebert (D.-La.), and the House Military Operations Subcommittee headed by Rep. Chet Holifield (D.-Calif.). GAO launched its investigation in November, 1958, after Air Force refused to give the agency a complete report on its ballistic missile program made by the USAF Inspector General (AW Nov. 17, 1958, p. 34). Air Force, backed by the President, stood its ground on executive privilege. GAO has completed two of the three sections of its report, which cover the program to the fall of 1959. It probably will reach Congress late this month. GAO has again run into classification complications with USAF and may submit parts of the report as classified documents, leaving the decision on release of information to the congressional committees. Meanwhile, GAO is continuing its investigation of the USAF missile program on a current basis.

• **Investigation of charges of "munitions lobby"** influence in military procurement will be released by the Hebert subcommittee. This report, scheduled for release in mid-January, is expected to make legislative and administrative recommendations to encourage retired officers to continue in government service, discourage fraternizing of officers and contractors and pressure publicity aimed at continuance of obsolete or duplicative weapon systems. Extensive hearings were held last summer (AW Aug. 24, p. 33), after legislation banning defense contracts to firms that hired former high ranking officers within five years after retirement from the service barely missed House passage.

• **Reorganizations in the space** and missile programs (AW Sept. 28, p. 27), including transfer of service programs to the National Aeronautics and Space Administration and the downgrading of Defense Department's Advanced Research Projects Agency, will be reviewed in a report by the Holifield subcommittee. The subcommittee last year called for merger of Army and Air Force, elimination of ARPA and establishment of Space Technology Laboratories, Inc., on a non-profit basis (AW Sept. 14, p. 146). The group is awaiting results of a study by the USAF Scientific Advisory Board on possible reorganization of STL before making its final report.

• **Legislative proposals** aimed at increasing defense business for small firms will be included in a report by the Senate Small Business Committee. These are expected to include a requirement for more competition in negotiated contracts.

• **Civil Aeronautics Board's** organization and ethical standards will be reported on by two groups—the House Legislative Oversight Subcommittee headed by Rep. Oren Harris (D.-Ark.) and a Senate judiciary subcommittee headed by Sen. John Carroll (D.-Colo.).

Nuclear Test Decision

Impatient with the Soviet attitude during 14 months of negotiations on nuclear disarmament, President Eisenhower last week declined to extend the U.S.'s self-imposed ban on nuclear testing which expired Dec. 31. He said, however:

"Although we consider ourselves free to resume nuclear weapons testing, we shall not resume nuclear weapons tests without announcing our intentions in advance of any resumption.

"During the period of voluntary suspension . . . the United States will continue its active program of weapon research, development and laboratory-type experimentation."

The U.S. announced a one-year moratorium on testing on Aug. 22, 1958, beginning on Oct. 31 of that year. The suspension was subsequently extended to Dec. 31. The President last week complained that prospects for agreement with the Soviet Union on a cessation of tests "have been injured by the recent unwillingness on the part of politically-guided Soviet experts to give serious scientific consideration to the effectiveness of seismic techniques for the detection of underground nuclear explosions."

Defense Disarmament Office

The recent disarmament proposals and the approaching summit conference, however, have led Defense Department to establish an Office of Disarmament Affairs within the establishment of the Joint Chiefs of Staff. New office is headed by Rear. Adm. Paul L. Dudley who carries the title of Special Assistant to the Joint Chiefs of Staff for Disarmament Affairs. Dudley, former member of the JCS Joint Strategic Survey Committee, will be responsible for reviewing all U.S. policies and proposals relating to disarmament as well as similar proposals advanced by other nations and advise the Joint Chiefs on just what action, or stand, should be taken.

Airspace Amendment Delay

Federal Aviation Agency has decided to postpone the effective date of an amended regulation that would raise the floor of controlled airspace from 700 ft. to 1,500 ft. Originally adopted by the Civil Aeronautics Board on Dec. 29, 1958, to go into effect on Jan. 1 of this year, the regulation will not become effective until July 1 in order to provide the FAA the "necessary time to complete analysis of the modifications to the national airspace structure to ensure that the agency's fundamental responsibility to provide for most efficient use of all airspace is accomplished considering the requirements of all airspace users." Main significance of the new ruling, according to the FAA, lies in flight visibility minimums. In controlled airspace, visibility of three miles or more is required for flights operating on visual flight rules while a minimum of one mile visibility has been established for visual flight rules operations in uncontrolled airspace.

—Washington staff

Space Technology

Early Warning Polar Satellites Studied

Anti-ICBM system would saturate north-south orbits to provide complete surveillance of earth's surface.

By Irving Stone

Los Angeles—System of unmanned satellites saturating a north-south orbit passing over the earth's complete surface is being projected as part of an anti-ICBM capability under study by Convair's San Diego Division under government contract. Details of the planning include these key considerations:

- **Approximately 500 satellites** probably will be built, based upon a timetable scheduled to feed in production-type hardware for 18 months beginning in mid-1964 after a flight-test program scheduled to start in early 1963 and end in early 1964.
- **Circular polar-orbits** of the satellites will be at an altitude of about 300-400 mi.
- **Time to orbit the earth** will be between 94 and 98 min.
- **Mission period capability**, or duration of time in orbit, will be targeted for three years.
- **One satellite configuration** projected is an oblong-shaped payload 8 ft. square in section and 20 ft. long. It would orbit in a horizontal attitude. A satellite this size could accommodate large amounts of equipment.
- **Most logical function** of the satellite, considering its operational date, might be to supply to ground-based anti-ICBM missiles early warning intelligence of an enemy ballistic missile launch from any point on the globe through the satellite's blanket scanning capability enhanced by the large numbers which probably would be in orbit simultaneously. Probability of this early warning use is bolstered by the recent statement of Convair Astronautics Division's Krafft A. Ehricke (AW Dec. 21, p 50), who reported that plans are under way to use selected infrared wave lengths in a detector which, in effect, would wash the earth out in gray tones and make visible energy sources that might emanate from the explosion of a nuclear bomb or the launching of an ICBM.

Launch Capability

An extrapolation of this basic capability might combine early warning with the ability to launch missiles from the satellite itself. This missile-launch capability from the satellite does not lie outside the region of technical feasibility, and this type weapon will receive serious consideration as missile and space technology advances. Big question is whether this capability could be developed within the time period scheduled for the operational readiness of the satellite system in mid-1964.

Electronic countermeasure capability in the satellite for effective confusion of enemy ICBMs would be a difficult—but not impossible—achievement, requiring a large electrical power source in the satellite. Space technologists generally feel that it is easier to develop destruction capability than confusion capability.

- **Reliability requirement** will demand that functional failure for the satellites' power supplies will not exceed 20% per year for the duration of the three-year mission. This means that, on the average, four out of every five satellites in orbit each year will be expected to be operational.

One of the most critical problems in satellite system capability is power dependability. Long mission duration coupled with continuous draw and high peak loads taxes reliability severely.

Power Considerations

Convair's approach to provide a reliable solution to the airborne electrical power requirements for the anti-ICBM concept employing a satellite as a means of defense considers two schemes:

- **Radioisotope auxiliary power system.**
- **Solar energy auxiliary power system.**

Convair already has solicited preliminary feasibility and technical information from prospective industry members who might bid for the auxiliary power system. In addition to this information, proposals have been requested for a six-month study effort with a starting date that was tentatively set for Jan. 1. This may result in a design competition leading to establishment of a team to submit an integrated proposal.

Titan Management Realignment

Denver—George M. Bunker, chairman of the Martin Co., today assumed personal charge of integrating all aspects of the Air Force-Martin Titan ballistic missile project into a single company division with headquarters here. Bunker has moved from Baltimore and will make this his base of operations indefinitely.

Until now, three divisions have been involved in the Titan program—the Denver Division, for development and some testing; the Cocoa Division of Cocoa Beach, Fla., for preflight and launch activities, and the recently organized Activation Division here, for activating Titan bases and helping integrate squadrons into the bases.

Under the new arrangement, the Denver Division, the Activation Division and the Titan activities of the Cocoa Division are being integrated. H. W. Merrill, formerly vice president and general manager of the Denver Division, is now vice president and assistant general manager of the over-all Titan program. Bunker retains his position as company chairman and also becomes general manager of the Titan program. Bunker said the various Titan activities are being consolidated because the missile is now entering upon the most important phase of its development and test program.

Another attempt to make the first flight test of second stage propulsion is expected this week. Two earlier attempts—on Aug. 14 and Dec. 12—resulted in explosions of the missiles on the launch stand at the Air Force Missile Test Center (AW Dec. 28, p. 17).

Titan's first four flights were successful last Feb. 6, Feb. 25, Apr. 3 and May 4. Since then, one missile was destroyed in a static test at Denver. After personnel "procedural errors" caused damage to one stage in each of three missiles, the company made some minor organizational realignments within the Denver Division to try to eliminate any such errors in the future.

Recently, Air Force Ballistic Missile Division and Space Technology Laboratories, Inc., which has systems engineering and technical direction responsibility for the Titan program, surveyed the situation and suggested other ways to improve quality and reliability control methods.

The company said Bunker's assumption of the role of general manager of the Titan work has nothing to do with previous organizational changes aimed at tightening test procedures or with the BMD-STL study. The integration of Titan activities under Bunker reflects the growth in size and importance of the project, the company said.

SATELLITE used with anti-ICBM system is projected to have oblong configuration 8 ft. square in cross-section and 20 ft. long, fitted with collector panels for solar auxiliary power system. Inset shows satellite with collector panels folded for stowage. Another version of the satellite would use radioisotope auxiliary power system. The anti-ICBM satellite would be put into polar (north-south) orbit and would circle the earth in 94 to 98 min.

Following this study effort, Convair contemplates a research and development program for the power supply to extend over two years, leading to delivery of a prototype APS in the middle of 1962.

Six flight test units are scheduled to be funneled into the program during a one-year period beginning January, 1963.

A tentative production schedule anticipates that 500 auxiliary power units will be built between the middle of 1964 and the end of 1965.

Requirements for both APS systems —the radioisotope and solar types—are generally similar, but differences are introduced peculiar to the characteristics of the particular system.

The radioisotope system conversion method would be by thermoelectric or thermionic means and would use chemical batteries or rechargeable fuel cells for the energy storage. Under the radioisotope APS approach, two variations in system designs are being considered—a basic scheme involving a minimum investment in isotope source and an alternate scheme based upon minimum battery storage capacity.

Power requirement for the satellite will be broken into duty cycles according to variation in operational demands during the orbit:

• **Direct current power** for the satellite will demand that the auxiliary power system be capable of supplying 300 watts on a continuous basis for one complete orbit (at least 94 min.).

• **In addition to this basic** power requirement, other scheduled loads will demand that an additional 740 watts be supplied for 7 min. once during each orbit, as well as an additional 330 watts for 5 min. once per 100 orbits.

• **Unscheduled d.c. load capability** will demand that, in addition to the scheduled loads, the auxiliary power system will have to be able to supply once-per-orbit 7,500 watts for 2 sec.; 3,500 watts for 30 sec., and, after this, 2,800 watts for 15 sec.

• **Alternating current loads** also are included in the power requirements based upon an inverter efficiency of 70%. Continuous a.c. requirements will demand that 175 watts be furnished during one complete orbit.

• **In addition, the a.c. system** will have to put out 300 watts for 7 min. once per orbit and 55 watts for 5 min. once each 100 orbits.

For the basic design—minimum amount of isotope source—the power system will have to supply the continuous draw and charge the battery or fuel cell to compensate for scheduled load depletion.

The cumulative effect of the battery, or fuel cell depletion as a result of repeated random applications of the various unscheduled loads, will be 2,000 watt-hr. for the mission duration—three years.

Electrical power characteristics available from the battery or fuel cell storage system at the end of the satellite mission, when subjected to the unscheduled peak loads, will have to be 115/200 a.c. volts plus or minus 2%, 3-phase 400 cps. plus or minus 0.5% and 28 d.c. volts plus or minus 10%.

The alternate radioisotope auxiliary power system design—minimum battery storage capacity—will have to provide continuous power demand plus scheduled loads without recourse to battery or fuel cell storage. The battery or fuel cell will supply power for all unscheduled loads. In other respects, the system demands for the alternate design are equivalent to those for the basic design.

Isotope shielding will be a shadow installation to limit the three-year cumulative dose to 100,000 REM (Roentgen Equivalent Man).

Power requirements for the solar auxiliary power system design are the same as those required for the basic radioisotope APS design. The conversion method would use photovoltaic cells, and energy storage also would be with chemical batteries or rechargeable fuel cells.

Collector orientation would be about a single axis and permit compensation for the annual variation of the orbital plane with respect to the sun. In addition to emphasis on the mechanism for the orientation of the collector, the design proposals will have to spell out details for its storage and deployment.

In the 8-x-8-x-20-ft. satellite con-

figuration, the upper halves of the two sides only will be available for the installation of the auxiliary power unit proper.

During the satellite vehicle boost phase, the APS will have to withstand a maximum lateral acceleration of ½g, and a maximum axial acceleration of 8½g.

Maximum internal surface temperature of the compartment enclosing the APS is expected to be 500F for 100 sec. at a pressure altitude of 200,000 to 400,000 ft.

Reliability, weight and cost will be emphasized in the design of the auxiliary power system, and proposals will have to specify predicted reliability of major components, outline the present state of development of critical components on the basis of tests or computed reliability and specify the basis for predicted improvement from the present state of development.

Integrated Agency Is Urged To Coordinate Scientific Efforts

By Craig Lewis

Chicago—Central government organization and coordination of the nation's science efforts under a single federal agency was recommended last week by Dr. Wallace R. Brode, science advisor to Secretary of State Christian Herter.

Brode said a study commission should be established to consider reorganization of government science agencies and programs and examine the relations between government and university and industry efforts. He spoke to the annual meeting of the American Assn. for the Advancement of Science as retiring president and stressed that his views were personal rather than official.

At the same meeting, Dr. T. Keith Glennan, administrator of the National Aeronautics and Space Administration, discussed the current prominence of engineering work in the scientifically-oriented space program. These other views also were presented:

• **Surface of Venus** was described as too hot for life or water to exist by Frank D. Drake, of the National Radio Astronomy Observatory. Citing radio measurements which indicate the surface temperature has been about 585F over the past three years, Drake theorized that the Venusian surface probably consists of barren rocks and deserts. Drake also said studies of Jupiter indicate the planet has a radiation halo that would be 100 times more dangerous to human life than the Van Allen belts around the earth.

• **Danger of undesirable** side effects from computers designed with limited learning powers was described by Norbert Weiner of the Massachusetts Institute of Technology. Weiner warned that such learning machines must be given clear, unambiguous instructions to avoid unexpected and undesirable effects.

Discussing the concepts his proposed study commission would cover, Brode suggested a regrouping of scientific agencies and activities under a Department of Science, a National Science Institute or some other coordinated organization. He said a well-developed coordination should be developed between such a department and those agencies not incorporated into it so that a comprehensive national science program can be maintained.

Realignment of distribution methods and responsibility for support of basic research at educational institutions should be studied, Brode said, and there should be a move toward university grants administered by a science department rather than by the applied agencies, such as the Departments of Agriculture and Defense.

Brode suggested separation of major government-supported research institutions from the educational and industrial system, especially institutions involved in applied science. He said there should be greater acceptance of the operation of such institutions under an improved system of direct government administration.

Under Brode's recommendations, a National Science Council should be established to handle liaison between government scientists and academic and industry scientists "in such a manner as to be compatible with the maintenance of our broad culture and balanced development."

Brode said that if the concept of a national science policy is adopted to guide U. S. scientific efforts and a Department of Science is proposed, it should be "in fact as well as in name an operating department. It should not be a superstructure imposed on existing organizations, but it should be an honest and real effort to mesh the scientific interests and objectives of our government in the fullest utilization of resources.

"Thus, a Department of Science, while not removing from applied agencies, such as Defense and Agriculture, their research program specific to their mission, should, however, include all major segments of science not specifically pertinent to an applied mission."

Brode said the department should have separate bureaus to deal with space, atomic energy, medicine and other fields and that the director of each bureau should be aided by an advisory panel drawn from government, academic and industrial sources in his field.

The policy which the science department would follow would be created by a National Science Council, an advisory group of academic, government and industry representatives that would provide "broad advice which might be helpful in arriving at decisions on extent and character of support which the government should provide to science programs both in the government and through contracts or grants in aid to industry and universities, in short the implementation of a national science policy."

Discussing the multiplying top priority projects that compete for funds, Brode said a crisis has been reached in the overlapping expansion and growth of scientific programs so that none of these major programs can be supported except at the expense of less glamorous, but still essential, areas of science. Brode, blaming this crisis on expediency, said:

"The immediate conditions and circumstances existing at the time determine which programs are top priority. Even when the stimulating conditions have been removed, the top priority label is often maintained. Then another set of circumstances dictates the creation of another top priority label assignment to another area of science."

Latest contender for the top priority label is space, and oceanography, weather or materials research present good future prospects. Brode said that "We do favor advances in these areas of science; we need this progress, but this progress should not be effected by a corresponding reduction in the rate

Galaxy Age

Los Angeles—Astronomers have discovered a cluster of stars in the earth's galaxy which are an estimated 24 billion years old, the oldest bodies discovered in the universe by a wide margin.

Discovery of MGC188, a group of stars in the Milky Way galaxy, which also contains the solar system, was reported to the American Physical Society by Allan Sandage, of the Mt. Wilson and Palomar observatories. Star cluster is estimated to be about 3,000 light years from earth. Age measurement was made by amount of their hydrogen content the stars had burned.

This discovery is more than twice the age of the 10 billion year old star group reported last October by English astronomer Fred Hoyle.

of advance for equally important areas of science." He said a national science policy is needed to make a wise and rational distribution of scientific activities and resources.

Enthusiastic scientists all dream of substantial support for their pet programs, Brode said. "However, there must be a limit, and not only must scientists realize that there should be a relative priority assigned to areas of science, but there should also be recognition that scientific programs do not all have priorities overriding economic, political, educational and social developments."

Surveying various past efforts to coordinate U.S. scientific activities, Brode observed that the President's Science Advisory Committee saw a need for closer cooperation between federal agencies and recommended establishment of a Federal Council for Science and Technology. This group, headed by the President's science advisor, was established by the White House in March and consists of policy members of departments and agencies dealing in science, many of them non-scientists.

Brode said it would seem reasonable for Congress to be able to risk advice and counsel from a coordinated government science leadership, but he recalled that the chairman of the Federal Council refused to testify before a congressional committee on proposals for a Department of Science. "The council chairman declined to appear on the grounds that he was a privileged member of the President's staff, yet as head of the Federal Council for Science and Technology he was responsible for the organization which was charged to make recommendations for the creation of effective means to promote a more efficient coordinated science program in the government," he said.

"It was my own opinion which I expressed when, as president of the American Assn. for the Advancement of Science I was asked to appear before the same congressional committee, that a strong and responsible Federal Council for Science and Technology might well evolve into a Department of Science.

"The inability of the Congress to draw on the advice of the existing Federal Council for Science and Technology is in itself an indication of the need to separate our science coordination direction from the President's own office and advisor so that the coordinated leadership in science in the government might be able to speak with the authority of the group it represents rather than only through the President."

Commenting on the rejection of the science department idea by the President's Science Advisory Committee, Brode noted that the excuse given was that gathering all government scientific and technological operations in one agency would be unsatisfactory because it would remove the work too far from the user agencies.

Brode termed this a "synthetic defense" because elimination of research or development work necessary to the proper mission of an agency was not contemplated. He also rejected arguments that centralization of the scientific effort would impose too much government control and create too much centralization of authority. "Neither argument is tenable if the proper administration is provided and safeguarded," he said.

Brode said the government has an obligation to support a major share of the nation's research and applied science programs, but he said there should be revision and realignment to provide "more direct and less controlling support" to universities and greater direct support to government laboratories. He also said:

"Serious consideration should be given to reduction or elimination of convenience or synthetic scientific agencies which, while operating as non-government laboratories or institutions, are doing almost exclusively government work with government funds. Such laboratories should be made bona fide government laboratories and should be so directed and operating conditions set so as to permit the government to do its own essential scientific work with the working conditions which are most conducive to efficient and effective operation."

To keep good scientists in government, Brode said high-level policy and research jobs must exist as incentives for the scientists' ambitions. He noted that non-government organizations are maintained at Los Alamos, Oak Ridge, the Advanced Research Projects Agency and other places to provide scientists more pay and responsibility and better working conditions than can be provided under the civil service system.

"It would seem that a number of these contract operations in science and technology should be re-examined to determine whether there should be an improved status to government employment and the direct absorption of much of this work in a Department of Science or other coordinating structure in our government," he said.

NASA Administrator Keith Glennan told the AAAS meeting there is a tendency in science for specialists to penetrate so far into their chosen subjects that they "dig themselves deep out of sight, out of hearing, out of understanding of what other scientists are doing in their own and neighboring fields." Even more alarming, he said, is the growing cleavage between science and scientists and persons in other callings.

Glennan suggested the need for a new type of specialist—a "relater"—to find effective means of relating the knowledge and work of the physical scientist, the engineer, the political scientist, the humanist and other disciplines.

Discussing the role of the engineer in the scientifically-oriented space program, Glennan pointed out that, while the experiments are scientific, engineering is making them possible. Currently, more than 85% of NASA's work is aimed at solving the engineering problems involved in the design, construction and operation of launch vehicles, payloads and tracking stations and in the acquisition and reduction of data.

"These essentially engineering functions support and underwrite the work of the experimental scientist as he goes about his task of seeking out new knowledge of the universe through the windows in space now being thrown open to them," he said.

Dutch Select F-104G

Geneva—Royal Netherlands air force will be re-equipped with Lockheed F-104G Starfighters, following the lead of West Germany and Canada in choosing the fighter-bomber version (AW Nov. 16, p. 34).

The decision in principle was announced officially by the Dutch government late last month. It did not specify how many airplanes would be bought or any details of unit or program cost. A Netherlands air force spokesman said that financing remained to be worked out.

Most observers believe the Dutch requirement is for 200 airplanes replacing all Republic F-84F and RF-84F fighter bombers, North American F-86K all-weather interceptors and Hawker Hunter day fighters now in service (AW Dec. 21, p. 20).

The Dutch industry expects to build a major portion of the order with Fokker doing airframe work and Philips handling avionic production. The Starfighter's General Electric J79 powerplant could be built in Belgium if the Belgians order the same airplane.

The unilateral decision by the Dutch came as a surprise to most observers who expected a joint Belgian-Dutch decision some time this month. It followed a second meeting of Defense Ministers S. H. Visser of Holland and A. Gilson of Belgium Dec. 21.

Speculation is that the Belgians said at the meeting they were not in a position to make a decision and could not say with certainty when they would be able to do so. However, Belgian sources were not able to comment on this speculation.

Belgian sources also indicated that they might reach their own decision within a week or two.

Space Technology

Mercury Pilots Probe Weightless Flight

By Evert Clark

Washington—Recently completed series of zero gravity flights by the seven Mercury space pilots provided the most comprehensive study thus far of man's reaction to the weightless state and has given the pilots from 14 to 16 min. each of experience in a weightless condition.

Flights were made over a period of three weeks in a North American F-100F at the Air Force Flight Test Center, Edwards AFB, Calif. The joint study was conducted by National Aeronautics and Space Administration's Flight Research Center there, the AFTC and a 12-man team from Air Training Command's School of Aviation Medicine.

Mercury pilots and the aircraft were instrumented and measurements were recorded in the plane and also telemetered to the ground. Initial studies of the data collected indicated no unusual reactions to weightlessness, but the records will be given intensive analysis at the school.

Training Review

The Mercury pilots are now back at NASA Space Task Group headquarters at Langley AFB, Va., for a short period to review the training they have undergone since last April and to plan the next six or eight months of the training program. Training in that period is expected to include:

- **First testing of the combination of** prototype B. F. Goodrich pressure suits, McDonnell Aircraft Corp. couches and the centrifuge at Navy's Aviation Medical Acceleration Laboratory at Johnsville, Pa. The centrifuge will simulate the Mercury capsule flight environment of 5 psi. absolute, equal to ambient air pressure at 27,000 ft. The Mercury pilots have accumulated about 10 hr. each in the centrifuge, flying profiles that simulated only the positive accelerations they will experience as a USAF-Convair Atlas boosts the capsule out of the atmosphere and as the capsule reenters after orbiting. Pressure and temperature were not simulated. Glass fiber couches were molded to fit the pilots as they were dressed in ordinary flying suits.
- **Flight simulation** in NASA's Multiple Axis Test Inertia Facility (MATIF) at the Lewis Research Center in Cleveland, Ohio (AW Nov. 30, p. 19). This facility, installed in the Altitude Wind Tunnel, simulates roll, pitch and yaw of the capsule and altitude and temperature factors of space flight.
- **Survival, disorientation** and communications training at Navy's School of Aviation Medicine at Pensacola, Fla.
- **Concentration on the engineering** specialty areas assigned to each pilot and trading of what already has been learned by each man about his specialty. In addition to having been on the road as a group for a good part of the time since last August, the pilots have been making individual trips in connection with their specialties—for example, Leroy G. Cooper, whose area is the Army-Chrysler Redstone booster, has made trips to the Army Ballistic Missile Agency at Huntsville, Ala., and the Air Force Missile Test Center at Patrick AFB, Fla.
- **Further study of the McDonnell** capsule itself and participation in the mating of the capsule to the Redstone booster.
- **Continuation of academic training** which has moved from basics into specific propulsion systems, navigation problems, etc., connected with Mercury.
- **Continuation of instrument** proficiency flying in Convair F-102s. This is aimed at maintaining proficiency in perception of and reaction to instrument readings.

Delivery of the first McDonnell capsule is due soon. Capsule qualification tests using the Little Joe and Redstone boosters will follow shortly thereafter, and the first manned suborbital flight in a Redstone-boosted capsule may come before the end of Fiscal 1960—although the only real time commitment now in the program is to achieve at least one manned orbital flight in Calendar 1961.

Redstone Flights

NASA still hopes to send each pilot on a Redstone ride but this will depend upon how much money is appropriated for Mercury in the upcoming Fiscal 1961 budget.

Manned Redstone flights would send the capsule to about 105 mi. altitude and 250 mi. range, providing approximately 5¼ min. of weightless or near-weightless flight. NASA hopes to achieve a force of no more than .02g on these flights.

No other flights to gain weightlessness experience are scheduled before the Redstone shots. Maj. Willard R. Hawkins, of USAF's School of Medicine, who directed the recent flights at Edwards, says they produced "very valuable and important physiological data that heretofore we have never been able to achieve." He called the project, which resulted from more than a year's work by the School of Aviation Medicine and the Flight Test Center, "a first time, a first event wherein we have been able to collect this much physiological data from in flight."

Parabolic Trajectories

The F-100F achieved about twice the weightless period in flying parabolic trajectories that previous, lower-performance aircraft have provided. Since there is no other two-place U. S. aircraft that can appreciably increase the 50 to 60 sec. weightless periods achieved with it, Redstone will be the next step.

Final answers on the prolonged effect of weightlessness will have to wait until man has flown in orbit for extended periods of hours or days, Maj. Hawkins said. But he feels that a period of one minute is long enough for the body's normal responses to make an adjustment to the weightless condition.

Each Mercury pilot made four flights of about one hour each. On each, the aircraft was flown through three or four zero gravity trajectories of 50 to 60 sec. duration. Heart rate, blood pressure and respiration were measured continuously and telemetered to a ground station simultaneously with measurements of acceleration of the aircraft in all three axes, so that physiological information could be correlated precisely with the amount of gravity existing at any given time.

On the first flight, each pilot was required to perform tasks on a psychomotor work unit throughout the weightless periods. Response time and speed and accuracy of his ability to reach for objects or to specific points were measured to see how they differed from normal. Ordinary flight suits were worn.

On the second flight, pilots wore Navy Mark 4 pressure suits because the F-100F was not equipped to take the oxygen, ventilation and other connections on the prototype Mercury pressure suits. Pilots ate food of different sized grains, opening the face plate of the suit and squeezing the food from toothpaste type tubes provided by the Army Quartermaster Corps. They drank water from a squeeze type catsup bottle and an experimental bottle. In a normal

B-70 Cuts Reviewed

Washington—Reinstatement of some of the avionic subsystem-development programs, at least on a limited basis, for North American Aviation's Mach 3 bomber may be recommended by a special study team formed by Dr. Herbert York, director of defense research and engineering, following an investigation of the consequences of the recent B-70 cutback (AW Dec. 7, p. 26). Long lead-time items, such as the B-70 bombing-navigation system, are most logical contenders for reinstatement.

capsule flight, the pilot's suit would not be pressurized and he would travel with his faceplate open.

On the third flight, the Mercury pilots flew some of the parabolic trajectories themselves from the rear seat to allow them to measure their own responses and reaction times in weightlessness.

The fourth flight was a repeat of the first. This permitted comparisons to see whether pilot performance improved through exposure to weightless flight.

Flight Trajectory

Flights were flown by three pilots from the school. Equipment was checked out before takeoff and during the climb. At 40,000 ft. the aircraft was pushed to the highest Mach number consistent with fuel and time requirements, and a gradual dive was begun to increase speed without losing too much altitude.

Dive angle was 30 deg. by the time an altitude of 25,000 ft. was reached. Between 25,000 and 20,000 ft. maximum speed was reached, and the nose was rotated upward to an angle of attitude of 55 deg.

Power was reduced and, as the aircraft moved upward, zero gravity was achieved in all three axes. Depending on ambient air, the engine and the Mach number at which the weightless period was entered, it could be held over the top of a parabola that usually reached upward to 35,000 ft. One reached 45,000. The F-100F had to go over the top at an airspeed no lower than about 160 kt. to avoid compressor stall.

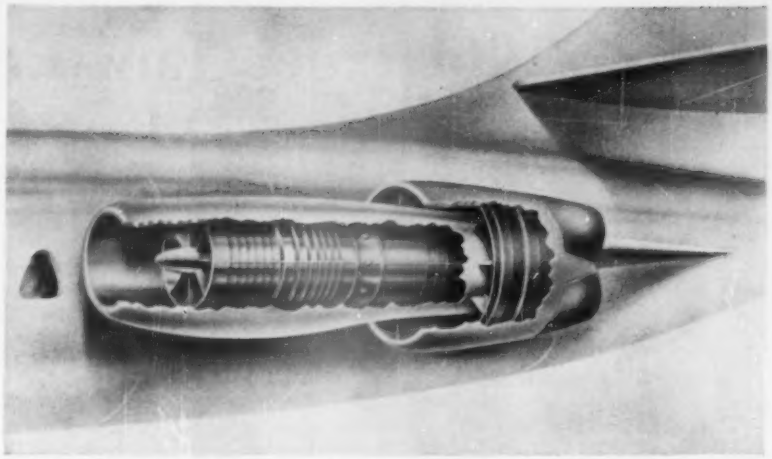
On the down side of the parabola, airspeed increased but weightlessness could be held until the aircraft reached 20,000 ft.

Dive angle sometimes reached almost to 90 deg. on the down side as the pilot attempted to hold weightlessness for as long as possible.

Psychomotor Task

A pull-out was made at no more than 3g. The aircraft could then climb into another parabola. In the case of the Mercury flights, however, the 3g's were held for a full minute immediately after the weightlessness period, to allow the Mercury pilot to evaluate the difference. In one flight, he had a psychomotor task to do or had to feed himself during the 3g period, and he also flew one.

Mercury pilots also transmitted flight reports of the type they will send from the capsule at both zero gravity and 1g, and there was no noticeable difference. Scott Carpenter said control tasks were much more difficult to perform in the centrifuge at as much as 14 to 16g than under a weightless condition in the F-100F.



AFT-FAN General Electric engine configuration is depicted on Sud Caravelle.

General Electric Buys Caravelle

General Electric has bought a Sud Aviation Caravelle to conduct flight tests of a Mark VII version of the two-engined jet transport to be fitted with General Electric CJ805-23 aft-fan powerplants (AW June 22, p. 71).

The engine manufacturer expects to receive its Caravelle in July of this year. It will be fitted with the aft-fan engines and go into flight testing at General Electric's facility at Edwards AFB, Calif.

Performance figures cited by General Electric for the Mark VII Caravelle include a 540 mph. cruising speed (see table). This compares with 515 mph. for the four Caravelles recently ordered by Sabena (AW Dec. 21, p. 28) with Mk. 6 versions of the Rolls-Royce Ra. 29 engine. Thrust of the General Electric engines is listed as 16,100 lb., compared with 12,500 lb. for the Ra. 29 Mk. 6. Range is listed as 2,000 stat. mi. for the aft-fan Caravelle vs. 1,500 mi. for Sabena aircraft (AW Oct. 19, p. 49).

Sud said a "family" of engines will be available for Caravelle operators including a new Rolls-Royce bypass engine, the R. B. 141. This will be available at about the same time or slightly later than the CJ805-23, according to Sud. Thrust of this engine will be around 14,000-15,000 lb.

General Electric and Sud said the Caravelle purchase and test program by General Electric "marked the beginning of a collaboration program" between the American company and the French manufacturer, and would result in the "early availability on the world market" of the Mark VII Caravelle.

The General Electric aft-fan engine will also power the Convair 600. The fan is a one-stage compressor-turbine system with combination compressor and turbine wheel. The wheel is free-floating, supported by two bearings. It rotates in opposition to the basic engine.

The thrust reverser is an external clamshell configuration.

The CJ805-23 is scheduled to go into flight test in early March on a Douglas B-66A leased from the Air Force. This airplane was used in testing the CJ-805-3, commercial turbojet engine which will power the Convair 880 (AW Dec. 21, p. 29).

General Electric will modify the nacelles of the Caravelle, install the aft-fan engines and begin the Caravelle flight program while the B-66A program is still under way.

Caravelle VII

(With General Electric CJ805-23 Aft-Fan Engines)

Takeoff thrust (Guar.):	16,100 lb. each engine
Takeoff gross weight:	110,230 lb.
First aircraft shipment:	October, 1961
Number of passengers:	68 first class; 85 tourist
Cruise speed:	540 mph.
Block speed* (500 stat. mi.):	408 mph.
Block speed* (1,000 stat. mi.):	460 mph.
Maximum stage length (full payload):	2,000 stat. mi.
Takeoff distance (500 stat. mi. trip):	3,900 ft.
Takeoff distance (1,000 stat. mi. trip):	4,450 ft.
Direct cost per passenger mile*	
500 stat. mi. trip:	$1.47
1,000 stat. mi. trip:	1.29
Direct cost per aircraft mile*	
500 stat. mi. trip:	1.25
1,000 stat. mi. trip:	1.10

* Cruising altitude:
25,000 ft. for 1,000 stat. mi. trip
20,000 ft. for 500 stat. mi. trip

Stable 1960 Sales, Low Profits Forecast

Washington—Continued high sales level during a period of major change is predicted for the coming year by the Aerospace Industries Assn., but no improvement in the industry's profit picture is expected.

Sales are expected to run well over $10 billion in 1960, close to the $11 billion level of the past two years. Sales trend of the dozen major airframe manufacturers paralleled the total industry figures in the past year, and AIA estimates for 1959 vary little from the $7.3 billion reported for 1958.

Profits of these 12 companies continued their decline and reached an earnings to sales ratio of 0.9% in the first nine months of 1959 as compared with 2% in the same period of 1958. Final profit rate for the year may show an improvement over the nine month figure, but the end of long production runs and the increase in research and development work are expected to keep profits low.

Reporting on the state of the industry in a period of major change, AIA President Orval R. Cook said the decline in military aircraft production was matched by increases in missile and space program spending to keep total sales volume at about the same level as in 1958. Increased commercial sales also helped offset the decline in military aircraft production. These same factors are expected to keep 1960 sales close to the 1959 level.

During 1959, production of military aircraft declined from the 1958 pace of 3,700 units to about 2,400. At the same time, spending for procurement and production of missiles rose to $3.49 billion for Fiscal 1959.

Backlog Decline

The decline in military aircraft production is reflected in the industry backlog, which dropped $1.1 billion between Jan. 1 and Sept. 30 last year. Backlog was $12.1 billion on Sept. 30, 1959, and reduction in orders for military aircraft accounts for about $750 million of the decline during the nine month period. Commercial backlog also declined slightly during the year as turbine transport deliveries increased.

Cook observed that changes taking place in the industry for the past several years had "exerted an especially acute impact" during 1959. He said these changes were primarily caused by the swing in emphasis from aircraft to high performance guided missiles and by the national determination to "provide for these new weapons, and at the same time maintain an existing offensive-defensive military organization under a relatively fixed budget ceiling."

Noting that current industry effort is concerned primarily with research and development rather than production, Cook said:

"To meet and solve these problems, aircraft and missile manufacturers have made and are continuing to make radical changes in their organizations in order to cover the broad scope of aircraft, missiles, spacecraft, their propulsion systems, guidance and related equipments.

"The impact of technological progress on the industry has been magnified by the cancellations, cutbacks and stretchouts of both development and production programs resulting from government efforts to operate within a fixed budgetary ceiling. Especially affected by these actions has been management's ability to reorganize and reprogram its efforts and activities on an orderly, sound and economic basis."

Increasing Competition

With the trend away from volume production and toward precision fabrication of limited quantities, Cook notes that "more and more companies are competing for fewer and fewer contracts."

Another effect has been the contraction of the industry from its April, 1957, postwar employment peak. By the end of last September, the total work force had dropped 18% to 730,000, but it is expected to remain at that level through the early part of 1960.

A change on the average skill of the work force resulting from the trend to more research and development work is reflected in wage trends. AIA reports the average hourly wage has increased from $2.51 in 1958 to $2.65 last September, and the average weekly wage increased from $101.91 in 1958 to $106.80 in September, 1959.

Cook called the increasing deliveries of turbine transports and their enthusiastic acceptance by the traveling public "perhaps the highlight of 1959." About 245 of these transports had been delivered to domestic and foreign airlines by the end of the year. Sales volume of smaller business and utility aircraft followed its upward trend, growing from 6,414 units valued at about $135 million in 1958 to 7,100 units worth $170 million last year.

Commercial Sales

Total commercial aircraft, engines, propellers and parts sales hit an estimated $1.7 billion last year as compared with $1.4 billion in the previous year. AIA estimates that commercial aircraft production, including helicopters, totaled 8,100 units in 1959, an increase of 1,240 units over 1958, and that the value of civil aircraft production increased 66% over the 1958 level. Of the estimated 260 transports delivered in 1959, 245 were turbine-powered, and manufacturers had orders for 432 turbine transports worth $2 billion at the end of October.

Helicopter operators in the U.S. and Canada increased from 120 to 160 during 1959, and the number of helicopters in service rose from 500 to 640 in the same period.

Thermoplastic Recording May Have Future in Traffic Control Radar

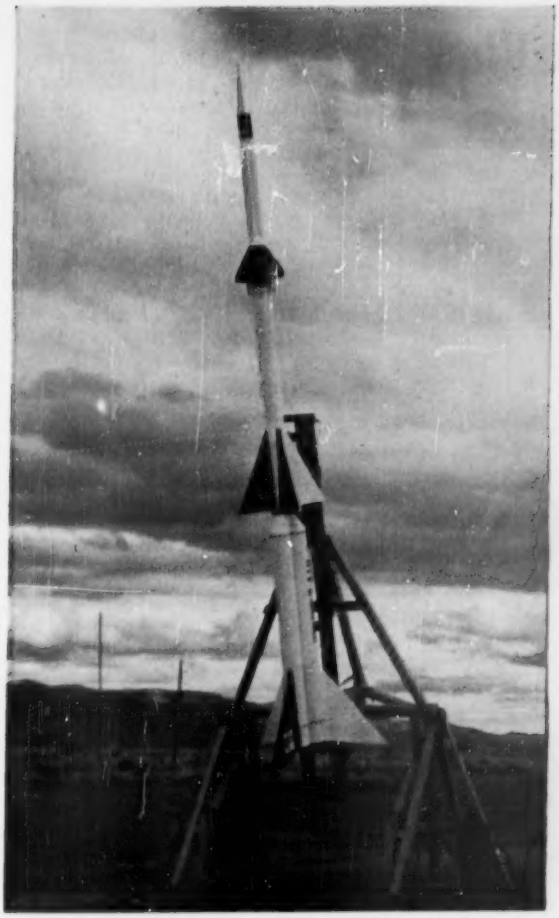
New York—Thermoplastic recording, a wide band and high density recording technique revealed recently by Dr. William E. Glenn of General Electric Co., may have important applications in military and traffic control radar, data storage and satellite surveillance.

The technique could challenge the position currently dominated by video tape and photographic film. Thermoplastic recording has resolution comparable to that of photographic film and a bandwidth exceeding that of video tape, according to Dr. Glenn.

With this technique, it may be possible to obtain large and high intensity displays of radar information for military or traffic control purposes. A corollary to this application, one industry source comments, would be color radar displays in which friendly aircraft could be distinguished from hostile aircraft by different colors.

High density of information storage of the new technique offers unusual advantages for computer applications and satellite surveillance. An informed source within the company indicates that a number of General Electric operating departments were apprised of this development over a year ago in an effort to spur applications work.

A thermoplastic recording sequence proceeds as follows: Charges are deposited by an electron beam modulated by the signal being recorded on the surface of a thin thermoplastic film—a plastic with a comparatively low melting point—superimposed on a high temperature substrate coated with a transparent



HTV-2 Rocket Attains Mach 10

Curtiss-Wright HTV-2 is launched at Holloman AFB, N. M., and attains Mach 10 within 10 sec. after launch. The three-stage research rocket was developed by Curtiss-Wright's Santa Barbara Division for USAF's Air Research and Development Division. A modified HTV-2 three-stage rocket recently launched an 18-in. Boeing model of a winged hypervelocity vehicle at Holloman AFB.

conductor. The thermoplastic is then heated by passage over heating electrodes, subsequently deformed by the electrostatic forces between the deposited charges and those of the substrate. Deformations are then solidified as the heat diffuses into the substrate after the film passes over the electrodes. Depending on the viscosity of the melted film, deformations can be formed in several milliseconds.

Images can then be projected in color or black and white by different optical systems or can be converted into suitable electrical signals.

General Electric hopes to get a head start in the development and application of thermoplastic recording, a source in the company says, but the company is expected to license the technique to others.

The thermoplastic film can be used, erased and reused thousands of times. Erasure is effected by reheating the film well above its melting point, thereby dropping its conductivity, and discharging it. Deformations are flattened out by surface tension of the film itself.

The thermoplastic technique is reported to be an outgrowth of a Swiss development using oil. Dr. Glenn reasoned, according to this report, that something more permanent could be achieved with film.

Dr. Glenn described a developmental thermoplastic recorder contained within a continuously pumped vacuum chamber to obtain higher writing density, and speed, and better reproducibility. The film, driven at a constant speed by a drive capstan, plays off a reel, is charged by the beam, then passes over the RF electrodes. An optical system can be installed after the RF electrodes to provide continuous monitoring of the recording (otherwise the film need not be heated and the deformations developed for several days as the charge patterns would be retained). Charges are deposited in a television type raster, with the electron beam sweep across the film providing the horizontal raster and the motion of the film supplying vertical sweep.

For reading color images, Dr. Glenn says, a condensing lens images line light sources in a projection system on a series of opaque bars before the projection lines. The film is placed between the condensing lens and the bars. When deformations form a diffraction grating, light will be defracted through the slots and imaged in a position on the screen corresponding to the position on the grating. Spacing and amplitude of the grating determine the color of the element and the intensity of the diffracted light, respectively.

The slots only permit passage of a single primary color. To form a color which is the sum of two or more primary colors two or more gratings each with a spacing corresponding to a single primary color can be superimposed.

For recording analog signals the intensity of a single electron beam can be modulated; for a split beam, both grating spacing and intensity are modulated. Binary digits can be made to appear as the presence of one of two colors, one for a "0," another for the "1."

Pilots, Carriers Debate FAA Plan To Alleviate Los Angeles Noise

By Robert H. Cook

Washington – Federal Aviation Agency proposal to relieve the aircraft noise and traffic control problems at Los Angeles by means of a special regulation has become a hotly contested issue between residents of the California city and virtually every phase of aviation using Los Angeles International Airport.

Against a background of complaints from Los Angeles residents who say they are being "tormented" by the "new and awesome" noise of heavy jet transport traffic, FAA has proposed a new regulation that would establish a traffic pattern area around the airport for a five mile radius and extend upward to a 2,000 ft. altitude.

Within this area, operating procedures, designed to route air traffic away from dwelling areas and reduce the noise problem by permitting aircraft to climb out faster, establish a preferential runway for landings and takeoffs by all aircraft whenever surface wind velocity is less than five knots. Traffic entry into the pattern would be made at a 45 deg. angle to the downwind leg of the runway with the aircraft required to maintain an altitude of 1,500 ft.

All jet flights between 10 p.m. and 7 a.m. would be required to use the westerly takeoff on the preferential runways with a rapid climbout above the ocean shoreline. Aircraft flying east would have to attain an altitude of 1,500 ft. before turning to an easterly heading. Takeoffs to the east, which would be permitted at other hours, would be made in a straight-ahead climb to 1,500 ft. before proceeding on course.

In a special ruling for jet operations, FAA said that required westerly takeoffs would depend upon having no more than a 10 kt. downwind so that, under most wind conditions, jet departures would be made over open water instead of residential areas.

Proposed Landing Rules

New landing rules for jets also would require the aircraft to approach at not less than a three degree ILS glide path slope from any point between the outer marker and the point of touchdown. Any aircraft not planning to land at the international airport or any of the three smaller airports in the area would be prohibited from operating within the designated airspace unless specifically authorized to do so by air traffic control. Aircraft using the nearby Hawthorne, Hughes or Santa Monica airports generally would enter and depart from the area at an altitude of 1,000 ft. However, aircraft weighing 12,500 lb. gross or less would maintain 600-ft. altitude.

Los Angeles and surrounding communities within the special traffic area have backed the FAA proposal, with some municipalities expressing concern that the suggested operating patterns should be further removed from their towns. The California Aeronautics Commission also backed the proposal but told FAA that the suggested changes duplicate existing state laws governing the issuance of airport operating permits. The commission said it favors settling the problem at the local level by further modification to state laws.

A number of private citizens in comments to FAA generally expressed support for the plan but most said it should be carried even further. Additional suggestions included mandatory noise suppressors for jets; all takeoffs to be made away from the area to the west; increased jet training for pilots; a boost in the glide path to eight degrees to further eliminate noise; establishment of noise monitoring stations, and the printing of carrier compliance records in local newspapers.

ATA Stand

Air Transport Assn., commenting for its member airlines, said it approves of the principle behind the planned regulation but objects to compliance with the three degree glide path altitude and night operational restrictions on jets. ATA said the suggested angle should not be stipulated until it has proven to be safe. Normal operating procedures, ATA said, allow the pilot to "undercut" the prescribed angle in order to "flare" the landing aircraft for touchdown near the end of the runway. Complying with the FAA proposal could result in using more runway space for landing and introduce a risk of overshooting, the association maintained.

ATA also said the airlines are "particularly disturbed" by the night restrictions on jet operations and feel that use of the preferential runway should permit jet operations on an unrestricted 24-hr. basis providing the takeoffs are made with a downwind limit of 5 rather than 10 kt. ATA also suggested that the plan, if adopted, should be temporary, lasting no more than a year, in order to permit a review at a later date.

Air Line Pilots Assn., contending that adoption of the rule would lead to "chaos, confusion and a compromise with safety," pointed out that turbojets cannot always meet the same variations in operating techniques possible with piston-engine aircraft. ALPA urged FAA to first formulate a general basic operational criterion for noise abatement procedures that could then become a guide for local application.

Major ALPA Objections

Among its major objections, ALPA criticized downwind jet takeoffs and pressed for easterly jet takeoffs as a safety measure regardless of the noise problem. Compliance with the current rules for night jet operations, calling for takeoff with a downwind component of nine knots, already have brought a number of complaints from pilots who contend it is difficult to become airborne under these conditions, ALPA said.

Imposition of the three degree glide slope altitude, ALPA said, would do little to improve safe operations and, because of the jets' characteristic of a high sink rate and the problem of checking inertia loads during flareout, result in hard landings under adverse weather conditions and attendant strain on the aircraft.

The pilots' union also objected to an FAA stipulation that pilots not wishing to use the preferential runways should file within 48 hr. a written report citing their reasons for requesting another runway.

ALPA says a note by the tower as to why the aircraft was not directed to a noise abatement runway should be sufficient.

Calling for a more practical solution to the problem of noise over residential areas, ALPA said, "regulations can only move the noise vertically or laterally. A satisfactory solution to the basic problem can only be achieved by a substantial noise reduction at the source or the removal of residential areas from approach zones at high density airports."

Both the Aircraft Owners and Pilots Assn. and the National Aviation Trades

Navy Selects Aztec

Navy has selected Piper's new, five-place Aztec executive transport as its "off-the-shelf" utility aircraft following an evaluation in competition with the Aero Commander 500, Beech Travel Air and Cessna 310.

Twin-engined Aztec has a top speed specified at 215 mph. and is powered by 250 hp. Lycoming O-540 engines. Commercial version, with exception of radio equipment, is priced at $49,500 (AW Nov. 2, p. 108). Piper has offered the Navy a support system—tied to its distributors and eliminating the stocking of spares—similar to that which Cessna provides USAF for its 310s (U-3As). Navy will utilize the Aztec within the continental limits of the U. S.

Assn. say they regard the FAA plan as unnecessary and one that places too great a limitation on light aircraft of less than 12,500 lb. gross weight.

AOPA noted that the traffic control area's ceiling of 2,000 ft. and the requirement that air traffic control have sole authority to permit penetration of the area could effectively close the entire area to any lightplanes operating under the ceiling because of poor weather conditions. The organization said its members have encountered this difficulty when they were refused landing permission, although weather conditions were still above the prescribed local minimums.

AOPA said it was reluctant to "put more power in the hands of controllers if such abuses are to be tolerated." The organization also objected to the requirement that would force light aircraft to use preferential runways since, it said, the smaller planes can climb out faster and turn away from departure paths without delaying traffic.

NATA had much the same objections and cautioned against any ruling that would permit controllers to shut down VFR traffic merely because they are "too busy." The organization also took issue with the 1,500 ft. traffic pattern at Los Angeles International for lightplanes on grounds that 1,000 ft. would be sufficient for noise abatement and would avoid the danger of the smaller planes being caught in the slipstreams of heavier aircraft.

The Airport Operators Council told FAA it approves the proposal but fears that it may not be extensive enough to solve the noise problem. Should it be adopted, AOCA suggested that the flight limitations be written into air carrier certificates and that each aircraft, as a condition of certification, be required to display a performance that would assure it could operate safely without any undue noise annoyance over inhabited areas.

The organization also suggested that the proposal be amended to require both the pilot and his company to justify any deviation from a preferential runway assignment and that westerly takeoffs follow an imaginary extension of the centerline of the runway until beyond the ocean shoreline.

NASA Will Form Biosciences Division

Washington—National Aeronautics and Space Administration is expected to create a Biosciences Division within the next few weeks to deal with aspects of the life sciences that concern manned space flight and effects of extra-terrestrial environments on all forms of life. Selection of a civilian to head the division is believed to have begun several weeks ago. NASA established a Bioscience Advisory Committee last August to survey U. S. capability in space-oriented life sciences work, outline present and future problem areas and recommend whether NASA should expand its activities in this field. It is understood that the committee recommended creation of a new division and suggested names of prospective directors for the division. The committee was chaired by Seymour S. Kety, chief of the clinical science laboratory at the National Institute of Mental Health at Bethesda, Md. Dr. Clark T. Randt, NASA space medical research scientist was executive secretary.

USAF Restricts C-121G

Washington—Air Force removed 63 Lockheed C-121G aircraft using the Curtiss-Wright R3350-91 engine from passenger service on Military Air Transport Service flights as a precautionary measure last week, pending special inspection and overhaul of the engines. The aircraft are continuing to haul cargo while waiting their turn for inspection.

Restriction is a result of a variety of engine troubles but not the result of accidents or major incidents, USAF said. Because of the seasonal lag in passenger flights, most of the slack is being taken up by Douglas C-118s, but MATS said there is a possibility that commercial carriers may be asked to carry a small amount of the traffic.

Aircraft affected are based at Charleston, S. C., in the Eastern Transport Air Force and at Naval Air Station, Moffett Field, Calif., in the Western Transport Air Force. MATS, which has had the best safety record in its history during Calendar 1959, stressed that the aircraft would have been grounded rather than restricted had the engine troubles created any real danger. The aircraft are seven years old, and complete inspection and overhaul was indicated, USAF said.

President Eisenhower's Transport, the Columbine, is not affected. It and other C-121s in MATS' Special Air Missions Division use other models of the R3350.

News Digest

Russian designer A. N. Tupolev is working on a medium-range transport to be designated Tu-124. The craft will feature "more powerful engines of a new type" designed by P. A. Soloviev.

ACF Electronics, a division of ACF Industries, Inc., located in Alexandria, Va., will be sold to the Illinois Tool Works of Chicago, effective Feb. 1, if directors of both companies approve, confirming earlier AVIATION WEEK report that ACF Industries would take such action (AW Oct. 26, p. 37).

Capital Airlines has leased seven DC-6Bs from Pan American World Airways to provide additional aircoach service on its route between Great Lakes cities and Florida. First of the seven aircraft will be available for scheduled service Jan. 28, following pilot training and modification of the aircraft to an 88-seat daycoach configuration. Increased capacity will boost available seats 22% on Capital's Florida routes.

Cessna and Piper Aircraft companies last week reported record sales for their 1959 fiscal years. Cessna sales were $105,786,000, or 10% higher than last year, and earnings rose to $7,937,000 or $7.41 a share compared with $5,109,000 or $4.84 a share the year before—a 55% increase. Piper sales rose to $34,263,000 compared with $27,109,000 the year before and earnings to $2,782,000 or $3 a share as against the previous year's $2,188,000 or $2.36 a share.

Bendix Aviation Corp. net income for Fiscal 1959 was $27,400,000 or $5.37 per share on 5,104,365 shares outstanding; figure is 29% higher than Fiscal 1958 net earnings of $21,171,902 or $4.18 per share on 5,063,825 shares outstanding. Fiscal 1959 sales totaled $683,800,000, 10% more than the previous year's sales of $619,138,095. Backlog on Sept. 30 was $511 million, compared with $465 million.

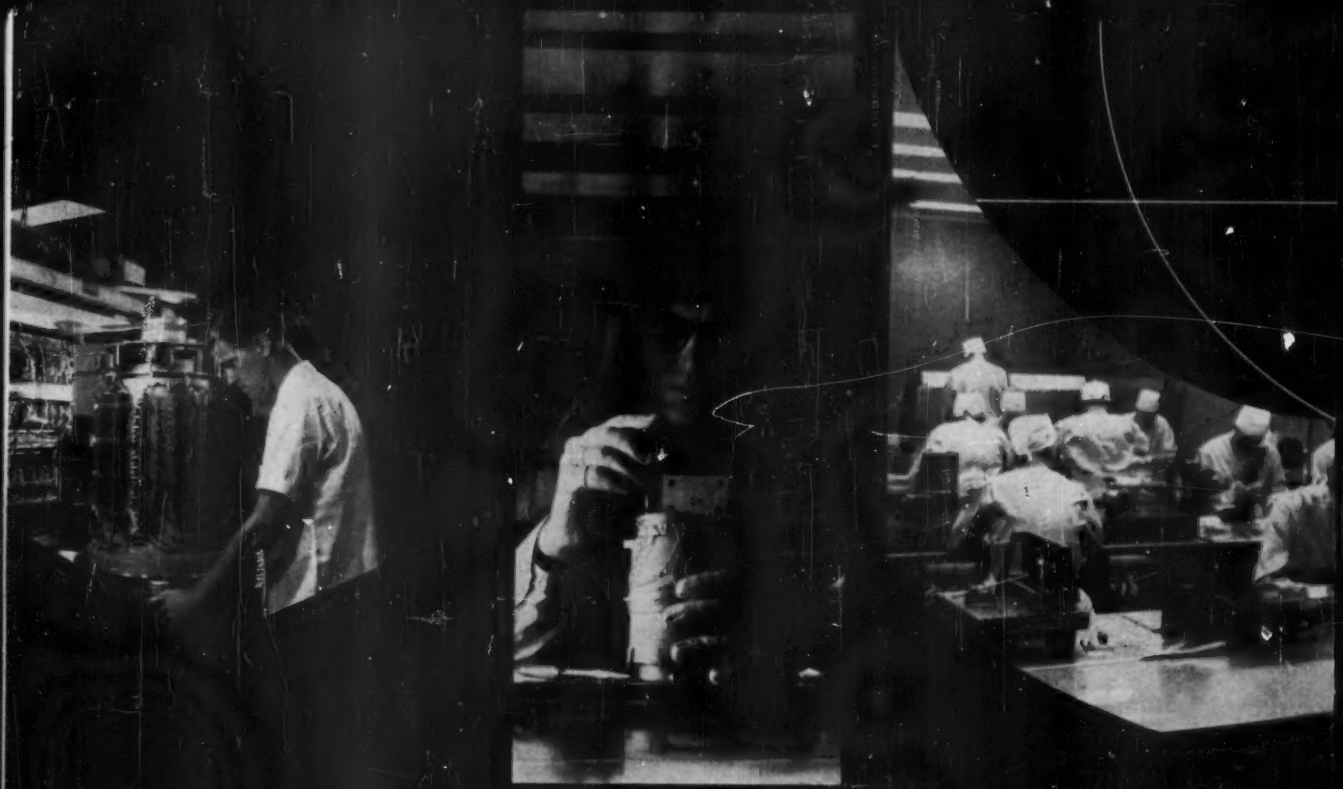
British Overseas Airways Corp. expects to receive this month the first of 15 Boeing 707-420s powered by Rolls-Royce Conway jet engines. BOAC hopes to put the aircraft into service over North Atlantic in April.

FAA Raps Decca

Washington—Federal Aviation Agency plans to announce this week that the Decca Mark 10 navigational system does not meet requirements for primary instrument flight rule navigation or as an air navigation steering device.

FAA conclusions, which are expected to draw bitter reaction from supporters of the British navigational system, were based upon flight tests of the system in the New York area from February to September of last year. Further research was conducted following the tests.

FAA is expected to cite about 10 technical and operational shortcomings of the system. Principally, FAA will report that its tests indicate that the device is subject to deviation of the tracking pen and loses zone identification in intermediate ranges. In addition, FAA also will express its dissatisfaction with the position heading aid, stating that pilots during the tests were unable to maintain constant heading.



Introducing a Major New Electronics Company

Four leaders in the field of electronics have been combined to form General Precision, Inc.—a new company with unique qualifications to serve this age of precision.

The four, which have become divisions of the new organization, are GPL (General Precision Laboratory), Kearfott, Librascope and Link. Each of these was formerly a subsidiary of General Precision Equipment Corporation.

The GP divisions today are pacesetters in airborne, shipborne and ground electronics subsystems. In their new integrated organization, they will also be better able to provide advanced control and support for major military subsystems, and to offer superior data handling systems for all military services, business and industry.

GENERAL PRECISION INC.

GPL DIVISION *is playing the major role in development of a new air traffic control system for the Federal Aviation Agency. It is the world's largest manufacturer of Doppler air navigation systems and a leader in closed circuit television for high resolution military and general business and industrial applications.*

KEARFOTT DIVISION *is one of the nation's leading producers of precision components such as gyroscopes, synchros, tachometer generators, integrators, accelerometers, servo motors and airborne hydraulic products. Kearfott is also a leader in the production of inertial guidance and navigation systems.*

LIBRASCOPE DIVISION *produces an unexcelled variety of digital and analog computers—from a one-half cubic foot digital computer for aircraft and missile navigation to a large-scale ground computer for air traffic control.*

LINK DIVISION *is the world's largest manufacturer of flight simulators and jet training equipment and also designs and produces specialized analog-digital computers, inductive identification and control systems for moving vehicles, microaccuracy gaging equipment and electronic systems for a wide range of industrial and defense applications.*

General Precision, Inc.'s plants in 14 cities across the country this year will provide employment for 15,000 people, including 4,500 engineers.

MANUFACTURING AND RESEARCH: Binghamton, Pleasantville—New York; Clifton, Little Falls, Paterson—New Jersey; Cambridge, Massachusetts; Asheville, North Carolina; Cleveland, Dayton—Ohio; Burbank, Glendale, Palo Alto, Sunnyvale, Van Nuys—California; San Juan, P. R. **SALES OFFICES** in 22 cities.
AFFILIATES, LICENSEES in Canada, France, Italy, Japan, U. K., West Germany.

Renault Airlifts All Auto Parts to U. S.

French company to ship about 1,500 tons of parts over Atlantic this year in 150 chartered planes.

By Glenn Garrison

New York—Renault, Inc., expects to ship about 1,500 tons of automobile parts across the Atlantic this year in 150 chartered planes.

The French manufacturer began moving all parts for its cars to the United States by air in November, 1958, and has airlifted about 900 tons of parts in 90 chartered flights since that time.

By shortening time in transit, reducing inventory, cutting packaging and handling costs and damage, the operation has resulted in a net dollar saving as well as making possible better service to Renault distributors and dealers in North America.

Classic Example

The experience is almost a classic example of the air freight sales approach which relates all distribution factors in estimating the cost of air versus surface transportation.

The Renault parts formerly moved by a combination of routine sea transport and emergency basis air freight via scheduled flights. They now move, on a weekly schedule, by chartered Douglas DC-6A and Lockheed 1049H aircraft from Orly Airport, Paris, to New York International Airport. Time from Idlewild to the bins of Renault's central parts depot in Queens, N. Y., is now a maximum of five working days, compared with 20 working days under the old system.

A planeload can be moved to the depot in two trailer trucks, whereas 12 platform trucks formerly were required to handle the bulky crates in which the parts were packed for surface shipment. By air, no crates are necessary and many parts are shipped loose, with light cartons being the only required exception.

At Idlewild, shipments are moved directly from plane to truck if they can get immediate customs clearance, or go onto an air freight dock to await clearance when necessary.

Transit time across the Atlantic by sea was two weeks and that meant carrying a much larger inventory than is necessary by using air transports. It also was necessary to crate the parts and send them by rail to the port of embarkation in France, usually Le Havre.

Damage to the parts ran about 50% in the sea operation, according to Guy Gaffet, manager of Renault's New York central parts depot. By air, damage now amounts to about 5%. This drastic reduction in damage helps the parts operation in several ways, including the reduction of extra-large inventories for parts particularly susceptible to damage, and savings in time lost when damaged parts are sent out for local repair.

From the central depot in New York, the Renault parts go out to 17 distributor warehouses in the U. S., Puerto Rico and Hawaii, where they are available to some 800 dealers. Movement from the central depot to these subwarehouses is not by air except for emergency purposes. Rate differential domestically is still too great to make the use of air profitable in this stage of the distribution, according to Gaffet.

It cost Renault about 40 cents per pound for the actual air shipment when the chartered operation began, Gaffet said, compared with 17 cents a pound by sea. The air rate now has been brought down to about 34 cents, largely through better handling methods developed by Renault as experience was gained in programing payloads. At the beginning, about eight tons were loaded on a DC-6A and 10 tons on a Super H.

This has been increased to 10 tons for the 6A and 13 tons for the Super H, and is expected to increase further, thus cutting the rate per pound of the shipments. New York now orders heavy parts once a month and lighter parts once a week, enabling the load planners in France to mix the parts for most economical loads.

Charters are set up 5 to 10 days ahead at maximum, but usually two or three days is sufficient time to arrange each charter.

Gaffet believes widespread use of jets will improve the cost picture further. Numbers of piston aircraft will be available for low-cost operation and production of the high-capacity jets themselves should bring lower rates. Air freight rates are coming down faster than steamship rates, he said.

Auto Shipment

Gaffet agrees with Francois Crouzet, general import manager of Renault's operation here, that air shipment of the automobiles themselves would offer many advantages but that presently it is out of the question.

While the company is interested in such a development, Crouzet sees it as presently in the "dream" stage and impossible with present aircraft. The cars are light for their space requirements in an airplane and ton-mile costs are therefore high. Exact space dimensions of proposed new aircraft, and possibilities for fitting in a maximum number of cars—for example, possible second-decking—are among the more important considerations to the potential air shipper of automobiles, Crouzet pointed out.

However, even the distant possibility

Renault Cost Comparison

Renault, Inc., imported $203,000 worth of auto parts into the U. S. during the three months ending Feb. 1, 1959, first such period in which all parts moved by air charter. Here is Renault's comparison of shipping parts by air and steamship.

	Air	Steamship
Packing (materials and operation)	$ 917.39	$ 7,216.82
Shipping	49,539.19	11,864.94 (stock orders, ship) 21,201.96 (emergency orders, air)
Unpacking		6,992.57
Inventory	5,096.63 (2-3 mo.)	10,193.25 (about 5 mo.)
Warehouse costs (space, personnel)	6,319.82	12,293.06
Total	61,873.03	69,762.60
Damage savings	10,000.00	
Total	51,873.03	

of importing the cars by air is of intense interest to Crouzet. Under the present surface system, about 15,000 cars are in the pipeline between factory and dealer at a given time, and the statistical average for a single car to get to its dealer is 44 days. Each dealer now must carry a minimum of a month's supply and program months ahead.

Renault's first use of regular airlift in its parts distribution occurred in exporting to England, according to Gaffet. The same problems of crating, handling, damage and the like led to chartering of twin-engine planes from Air France for the cross-channel operation. Renault first came to the U.S. in 1945, and regular use of air for parts movement has been under consideration for some time. Only recently, however, has the volume expanded to the point where the company found it advisable to undertake the experiment.

Air-minded Renault also was recently considering the operation of its own transatlantic airlift, leasing or buying surplus piston planes (AW Dec. 21, p. 34). Working on the basis of a six-plane fleet, the company found from its studies that the operation wouldn't pay.

The current charter airlift involves DC-6As for the most part with a few Seaboard & Western Super Hs. Other airlines include Pan American, KLM and Swissair.

Renault is the second largest exporter of cars to the U.S., with 14% of the market, according to Gaffet's figures. Volkswagen is first with 18%.

Volkswagen uses air transportation for its parts on an emergency basis only, a spokesman told AVIATION WEEK.

Renault imported 57,000 cars last year and the 1959 total will run about 100,000, Crouzet said.

Raytheon to Distribute by Air

Westwood, Mass.—Raytheon's Distributor Products Division expects next month to begin phasing in its new system of product distribution, involving routine use of air freight with automated order and inventory handling.

The Raytheon division's switch to air represents a major success for the airline sales approach based on relating transportation costs to the whole distribution pattern. In Raytheon's case, the decision to eliminate warehouses and supply distributors by air freight depended on the availability of the new communications equipment, Western Union Tel-O-Riginator. This equipment, which will transmit pre-punched order information from distributors throughout the country to the data processors at Westwood, has been available only recently, according to John Thompson, manager of the Distributor Products Division. A fast means of transmitting orders was needed and other methods, such as use of teletype, would have been too expensive for the operation to pay, Thompson told Aviation Week.

With the new distribution system, the division expects to cut duplicated inventories of its electronic component products by $2 million, to provide faster service and to save on tax, back-ordering and extra billing costs. Schedule calls for receipt of the first Tel-O-Riginator equipment Feb. 1 for use at Atlanta, one of the Division's four branch warehouses in the country. The regular basic use of air freight will begin at that time, and the Los Angeles, Portland and Chicago locations will be phased in in that order.

Meanwhile, the division is using air freight on a daily basis from Logan International Airport to test the airlines' performance in meeting schedules. Performance has been fine so far, Thompson said. American Airlines will handle the major portion of the air distribution. Much of the material now moving from Boston to the West travels in American's Boeing 707-120 jet cargo holds.

The Raytheon division operates a special warehouse near Westwood with semi-automatic packaging equipment to feed packages to trucks which carry them to the airport. American takes some of the material on an all-cargo Douglas DC-6A schedule which leaves nightly for the West. American handles the entire air freight operation, turning shipments over to other airlines where routes indicate. Eastern, for example, hauls the Atlanta materials. According to American, it had been working on Raytheon for five years to sell the "total marketing" concept. The airline has for some time maintained a "distribution consultant" program which includes analysis of a company's approach to its product distribution.

Raytheon calls its new system "Unimarket" and says it will provide 24-hr. deliveries to distributors in principal U.S. cities. Average time from order to delivery will be cut from seven days to one day, the company said, and in some cases 13 days will be saved.

The pre-punched cards, sent out with the merchandise, provide automatic inventory control. As the system is first phased in, Tel-O-Riginator transmitters will be located at district offices of the cities where the warehouses are now in operation. By the end of 1960, Thompson said, the division expects to have installed more than 200 sets so additional distributors can order directly from Westwood. Ultimately the system will include over 600 sets, he said.

During the early phase of operation at each branch warehouse, overlapping distribution will be used—i.e., the new system and the old one—to cover needs until the new system is fully operative.

Russian Pilots Attack Territorial Rivalries

Moscow—Russian airline pilots are complaining that they and their passengers are treated like unwelcome foreigners when they land at some Soviet airports located beyond the territory in which the plane is based.

Biggest target of criticism is the Irkutsk field, a major stop on Aeroflot's trans-Siberian run, which passes through several territorial administrations. Pilot I. Ryzhkov recently declared:

"Crews from other jet transport subdivisions who land at Irkutsk are not given the same treatment as locally-based crews. Thus they do not have an equal opportunity to fulfill their traffic quotas.

"When both 'foreign' and local planes are available, Irkutsk authorities channel passengers and cargo to 'their own' craft. The 'foreign' flights have to leave without full loads.

"Crews based at Irkutsk complain, in turn, about the narrow favoritism shown by officials at Moscow's Vnukovo field and Khabarovsk Airport.

"As the saying goes, Ivan blames Peter and Peter blames Ivan. In the final analysis, traffic profits suffer."

Ryzhkov also cited these examples of inefficiency at Irkutsk:

"A Tu-104 bound from Moscow to Khabarovsk landed at Irkutsk and was directed to a remote parking area. Ten-twelve minutes passed before two men dragged a defective ramp to the plane.

"Capt. Urubkov demanded another ramp. Thus the passengers were able to leave the plane only after waiting half an hour.

"Food for through passengers also fails to arrive on time. On one occasion, there wasn't any truck to bring it. Finally, after an hour, a truck was provided. Another hour was required to get the food and bring it to the plane.

"When Capt. Alekseyev landed his Tu-104 at Irkutsk, he asked for a heater. When none was sent, he ordered his flight engineer to find one. After two hours, the flight engineer reported back that there was only one heater in operating condition, and other planes which arrived earlier were still waiting their turn for it."

Fund Sales Spur Airline Stock Decline

By William H. Gregory

New York—Airline stocks have entered another trough of pessimism which appears to be in part reaction to the glow of investor optimism that greeted the introduction to jet equipment.

Investment analysts here don't believe the reaction will reach the depths of 1957's gloom when share prices on a level with book values were the rule.

Prices of the major trunklines have dropped 10-15 points since the highs reached last spring and summer. Some further though more modest declines were viewed as possible, but the general feeling is that the worst is over—barring a general retreat by the market.

Investment Trusts

Investment trusts, which can play an important role in setting trends because of their dealings in large blocks, tend to be the most avowed pessimists.

Whether such fund transactions were responsible for 65,000 shares of Eastern Air Lines changing hands one day just before Christmas (as against a normal day's volume of less than 10,000) is not clear, but investment men think so. Eastern and American Airlines, both fund favorites, have both been fairly active on the market in the last few weeks.

Fund selling has been going up since the second quarter. Such transactions are reported only quarterly, but the funds watch each other closely and a recent sale of a 70,000-share block of Northwest Airlines is common knowledge among them.

Less pessimistic are the brokerage house analysts. They recognize the same problems lie ahead, but weigh the effects differently. One debated point appears to be earnings projections for 1960, with the fund analysts in many cases foreseeing earnings at best no better than 1959.

And for still another viewpoint, there is that of a commercial banker interested in airline financing:

"I don't see why airline stocks went up in the first place," he said. "There's no more reason to be any more pessimistic now than there was a year ago. The problems were pointed out clearly before the jets were ever delivered, including the rise in capacity spelled out plainly in the Cherington report.

"In a lot of ways things have worked out better than we expected. We looked for a lot of red figures in the net income column this year. Our loans were written with that in mind. It's a tribute in many ways that the airlines have shown the earnings they have."

Problems cited most consistently as causes for concern:

- **Cost uncertainty.**
- **Impending capacity increases.**
- **Load factor declines.**
- **Competitive pressures.**
- **Doubts over the outcome** of the General Passenger Fare Investigation.

None of these is unfamiliar. But the interpretations of their weight and immediacy were varied.

One fund analyst was dismayed over cost trends in the last month or two. He felt costs were shaping up greater than expected for the jets and that more was expected in the way of productivity than has actually developed.

Another was worried over declines in load factors that began this fall and did not like the prospect he foresees of fare concessions of one sort or another next year as possible in response to competitive and capacity pressures.

Both were concerned over the increased fixed charges for depreciation and interest which have begun to make their appearance (AW Dec. 28, p. 26).

The highly leveraged condition of the airlines was not regarded as appealing, the point being made that air transportation isn't the kind of business where high leverage is advantageous. This is a reference to the large fixed debt carried by the airlines; in rapidly growing businesses, this can make for drastic increases in earnings as burgeoning revenues cover fixed charges with greater ease.

Dilution of Holdings

One factor that is worrying both the fund and brokerage analysts is the dilution of present shareholders' holdings if and when the airlines seek to raise more equity capital. Banks and insurance company lenders have made it plain to the airlines that they feel debt-to-equity ratios are high and that efforts should be made to alter the ratio when market conditions take a more favorable turn (AW Mar. 30, p. 47).

Just such moves by both American and Pan American World Airways last spring after their share prices had risen above $30 acted as an immediate damper on prices at the time. By midsummer some of the funds that had got into the airlines in 1958 had cleaned out their positions and others followed as prices generally sagged.

Sales by funds and a grim outlook for the future aren't always a cause-and-effect relationship. Though funds usually talk of long term investments, in practice they sometimes operate over relatively short periods. Thus the action of some funds could be viewed simply as the taking of a nice profit in hand rather than any deliverance of a judgment on the future of air transportation.

Optimistic View

Not all funds are apprehensive for the future in airlines. One large Boston institution analyst feels just the opposite. He made these observations:

- **Depreciation charges** because of rapidly obsolescing aircraft have obscured the growth in earning power of the airlines since World War II. Jets, he feels, will not obsolesce so rapidly and will help net earnings to some extent. Airlines may also de-emphasize the stress on cash flow and pay more attention to carrying revenue down into net income.
- **Jets,** being more efficient equipment, will begin to show cost savings next year.
- **Fears of load factor** reductions and excess capacity assume that management has no control over the situation and that offsetting moves cannot be made.
- **Fare cutting** may be no calamity. He believes fare reductions are the way that more business can be won.

This analyst made it clear airlines are speculative from an investment point of view and require patience by the investor, but that as speculative stocks go he believes their prospects rate above average.

United, Sud Negotiations

Chicago—Negotiations between United Air Lines and Sud Aviation for the purchase of 25 Caravelle turbojet transports (AW Nov. 23, p. 47) hit a snag recently when United asked the French manufacturer to accept some of its DC-6B and DC-7 aircraft as partial payment of the fleet purchase price. The French, unprepared for such a proposal, were reluctant at the prospects of entering the used-plane market and are now studying the plan to determine whether United's counter offer can be handled practicably.

Lufthansa Order

Geneva—Lufthansa officially revealed its decision last week to order the Boeing 720B medium range jet transport in addition to its long range Boeing 707-420s, as forecast by Aviation Week (AW Dec. 14, p. 50).

Size of the order is estimated at seven airplanes, probably including options. Powerplant for the 720B is the Pratt & Whitney JT3D-1 turbofan engine.

Boeing Rolls Out First 720 for United

First Boeing 720 in airline markings is rolled out at the Boeing Transport Division factory, Renton, Wash. United Air Lines has ordered 18 of the 720s (see pp. 36-37). This aircraft will be delivered to United in April, after completion of its test program.

Passenger, Cargo Gain Predicted by IATA

Washington—Significant gains in world airline passenger and cargo traffic were predicted for 1960 last week by the International Air Transport Assn.

Forecast figures released by Sir William P. Hildred, IATA director general, estimate that passenger traffic on both domestic and international scheduled services may reach the 103 million mark this year as compared with an expected total of 95 million for 1959, with cargo ton miles reaching 1.23 billion this year.

Greatest gains are expected in the North Atlantic market, Hildred said, with IATA predicting a total passenger volume of 2 million during 1960 as compared with an estimated 1959 total of 1.65 million. North Atlantic cargo loads also are expected to reach 110.5 million lb. this year as compared with 81.9 million lb. last year.

Major portion of the 1960 increase in passenger traffic is expected to result from the lifting of currency limitations on foreign travel by a number of countries as well as on new holiday fares which Hildred contends "should release a pent-up demand for air tourism (in other nations) second only to that of the United States."

In particular, Hildred said, liberalized money controls will help make the North Atlantic a "two-way street, as the airlines have so long hoped."

Aiding the growth of air cargo traffic in 1960 will be lower experimental rates for both specific commodities and bulk shipments up to 10 tons, he said.

IATA's estimates for world traffic were made on the basis of International Civil Aviation Organization figures covering the scheduled airlines of 74 member nations of ICAO.

Final ICAO tabulations showed a worldwide gain of 10% in passengers carried for a 1959 total of 96 million as compared with 87 million the previous year.

Cargo ton miles reached 1.29 billion in 1959 for a gain of 14% over the previous year, according to ICAO statistics.

PanAm May Lease 707-120 to Pakistan

Pan American World Airways is negotiating with Pakistan International Airlines Corp., state-operated airline of Pakistan, for lease of a Boeing 707-120 jet transport to be used on PIA's route between Karachi and London via Cairo.

Pan American will not confirm details of the proposal, but it is understood that agreement on terms may be reached this month and will involve operation with Pan American pilots until Pakistani pilots can be trained to fly the jet. Responsibility for maintenance costs will be borne by the Pakistan carrier.

Lease terms under discussion are said to involve payment to Pan American of about $50,000 per round trip made by Pakistan International.

The Pakistan airline expects to begin thrice-weekly service on the route next spring and the jet would be available at that time.

The deal may include an option to buy the airplane in two or three years' time.

1959 Traffic Figures Show Record Increases

New York—Preliminary reports by several airlines of 1959 traffic results show the highest passenger volumes ever carried, and marked increases in passenger miles flown.

Trans World Airlines reported an expected total of 5.5 million passengers carried, an increase of 16.5% over the 1958 total. Revenue passenger miles rose 23% to 5.66 billion. Jet passengers totaled 610,000 persons carried 1.172 billion revenue passenger miles.

TWA's earnings before taxes for the first nine months of 1959 totaled $18,353,000 for a net profit of $9,068,000, compared with a loss of $1,824,000 for the first nine months of 1958.

Pan American World Airways' Latin American Division carried 1,434,514 passengers in 1959, up 13%. Revenue passenger miles increased 14% to a total of 1,442,762,000. Cargo was up 10% to 82,631,548 lb.

Continental Airlines reported a 60% increase in over-all traffic, with a passenger total of 1,120,000 and a revenue passenger mile total of 675 million. The 1958 totals were 854,000 and 422,463,000 respectively. The airline began jet operations in June, 1959, and has carried 165,000 jet passengers.

National Airlines said its seat capacity rose 11% for the year and passenger miles totaled 1,157,961,000, highest in the company's history.

Trans-Canada Air Lines carried 3,100,000 passengers, topping the 3 million mark for the first time. Available seat miles increased 17.5% to almost 3 billion; revenue passenger load factor dropped from 70% to 66%.

AIRLINE OBSERVER

► Airlines will refine techniques of flight scheduling this year as a key factor in the competitive race for traffic (AW Dec. 28, p. 26). As a result, a general move on the part of the industry to use computers to determine the most productive flight departure and arrival times in the 100 major markets can be expected. Most carriers now feel that insufficient marketing information is being used to establish the most profitable operating schedules.

► **Australian government will make no move to break its deadlock with France over bilateral issues. France last month carried out its threat to suspend bilateral talks unless the Australians gave the privately-owned French carrier TAI operating rights into Melbourne and Sydney in lieu of Brisbane and Sydney which the carrier now serves (AW Nov. 9, p. 50). Australian officials claim that Qantas has no interest in a service to Paris and that concessions to TAI would be one-sided—particularly since TAI's DC-8 fleet now on order for delivery in May will present formidable competition to Qantas. Meanwhile, Qantas will accelerate its plans to purchase at least two Boeing 707 Intercontinental turbojets to meet the competition offered by Pan American World Airways with that model on the U.S.-Australia route.**

► British West Indian Airways is leaning toward the Convair 600 turbojet transport to fill the small jet order it contemplates. The Boeing 720 medium-range turbojet also has been under active consideration.

► **Major transition from Chicago's Midway Airport to O'Hare Field on the city's northwest side will be made this year as increasing numbers of turbojet flights are scheduled out of the latter airport. Number of flights will increase at O'Hare to a point where Midway will lose its long-time rank as the nation's busiest airport.**

► Civil Aviation Assistance Group has been established in Cairo to provide technical assistance to the United Arab Republic. The project, sponsored by the State Department's International Cooperation Administration, calls for a five-man team from the Federal Aviation Agency to plan and design an air traffic control and airways system and procure and install equipment for its operation (AW July 20, p. 51).

► **Federal Aviation Agency and Air Transport Assn. are conducting talks with Defense Department in an attempt to get the airline operating ceiling raised from an altitude of 35,000 ft. to 40,000 ft. Purpose is to permit more efficient performance at higher altitudes of aircraft powered with the Pratt & Whitney J75 turbojet engine. Smaller Pratt & Whitney J57 turbojets have been operating adequately within the 35,000 ft. ceiling now in effect on most jet airways.**

► Majority decision by the Civil Aeronautics Board to deny a request by three supplemental carriers to operate flights during the Christmas holidays in addition to the 10-flight monthly maximum established for supplementals on each route drew sharp dissents from Board Chairman James R. Durfee and Member Joseph Minetti. In "vigorously" disagreeing with the decision, the two dissenters said the public service requirements are not being met by failure to allow two of the supplemental carriers to provide additional service between New York and Miami during the Christmas season.

► **Northwest Airlines has signed a one-year contract with Air Viet Nam to train flight crews to operate the carrier's fleet of one DC-4 and five DC-3s. A seven-man Northwest team will train crews recruited from the Vietnamese air force to fly routes between Vietnam, Cambodia, Thailand, Laos and Hong Kong.**

► Airlines apparently have exhausted their supply of superlatives that has been used during the past four months to keynote advertising plugging turbojet service. In an ad supporting the inauguration of Washington-Chicago-San Francisco jet schedules last week, United made this boast: "Only DC-8 service to San Francisco."

SHORTLINES

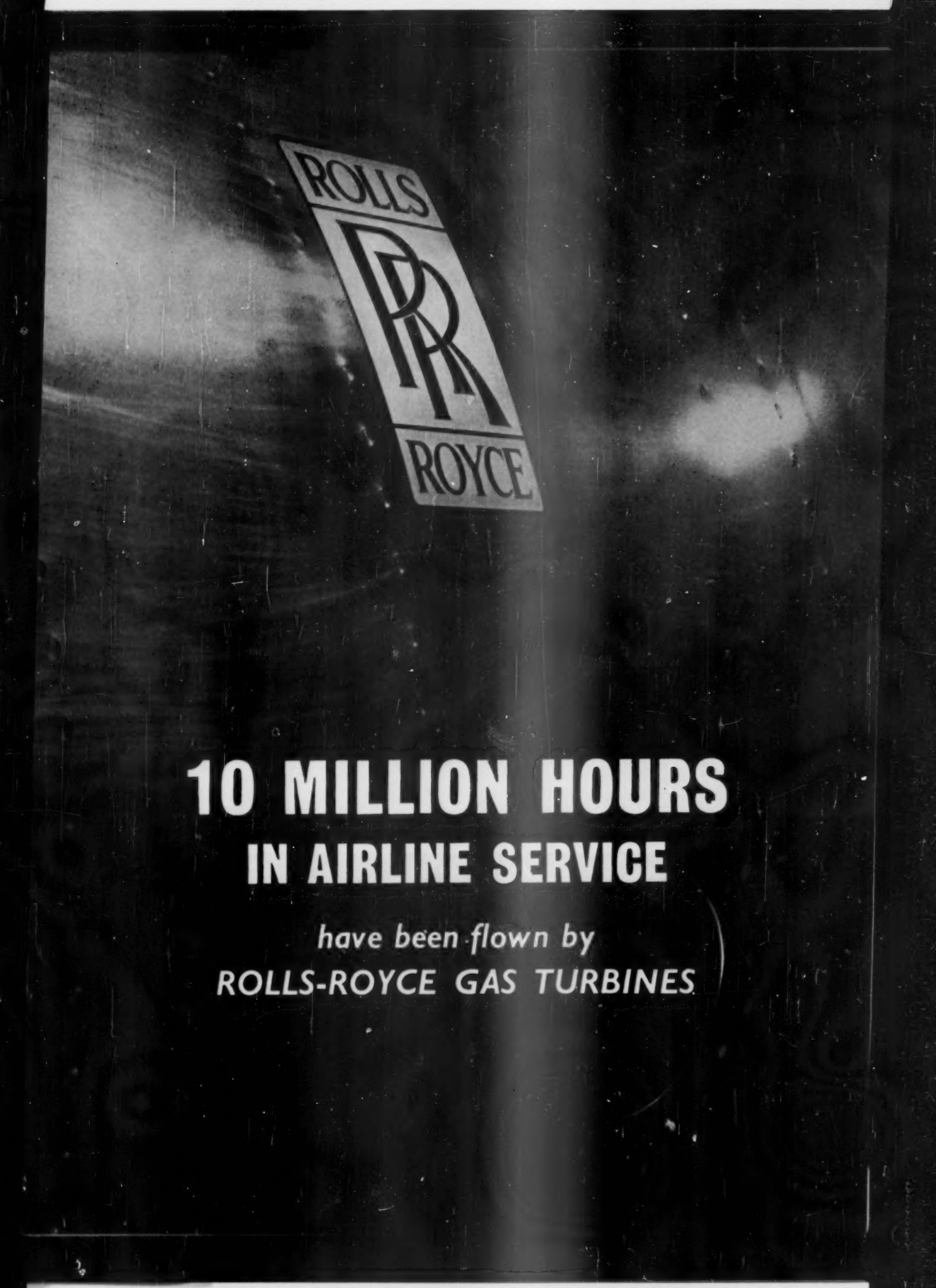
► **Delta Air Lines** has asked for Civil Aeronautics Board permission to eliminate the turbojet surcharge on Douglas DC-8 nightcoach flights to become effective Jan. 9. This would affect Chicago-Miami nightcoach flights as well as any future nightcoach flights on the airline's system. Delta plans to introduce the turbojet nightcoach service on Detroit-Miami flights on Feb. 1. Eastern Air Lines has filed a protest with the CAB, asking that the fare reduction be disapproved pending a full-scale investigation. The reduction would amount to $6.60 on a one-way ticket. Delta also plans to begin service into West Palm Beach on its Chicago-Miami route on Jan. 15 using DC-7s on a one-flight per day basis.

► **International Air Transport Assn.** says that airlines operating to and within Europe will have 90 of the newest turboprop and turbojet airliners in service on summer schedules beginning Apr. 1. IATA estimates the new aircraft will increase the actual carrying capacity of the airlines' fleets by 20 to 30% over the 1959 summer season.

► **Lake Central Airlines** reports that it has progressed with its equipment evaluation program to the point where it expects to make a decision within the next 90 days—probably in the turboprop field. The airline has conducted extensive studies on a Convair 340 converted to Allison 501-D13 turboprop engines, the Fairchild F-27 turboprop and the piston-powered Convair 340 and 440. Flight programs on the 340 and 440 were not considered necessary because of the existing flight data available from other airlines.

► **Trans-Canada Air Lines** has announced plans to begin construction of a $5 million turboprop and turbojet maintenance base at the Vancouver, B.C., International Airport early this year. Trans-Canada says facilities to be built for the airline's fleet of Douglas DC-8 turbojets and Vickers Vanguard turboprops will include a hangar designed to hold four DC-8s simultaneously.

► **Trans World Airlines** will offer reduced helicopter fares for passengers connecting between Chicago's Midway and O'Hare airports to and from TWA's jet flights to California subject to Civil Aeronautics Board approval. The reduced helicopter fare of $3 one way and $6 round trip on Chicago Helicopter Airways is 50% below regular rate. TWA, along with other carriers, already operates free ground transportation between the two Chicago airports.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Boeing 720 medium range turbojet transport is first of 18 ordered by United Air Lines and will be delivered in April.

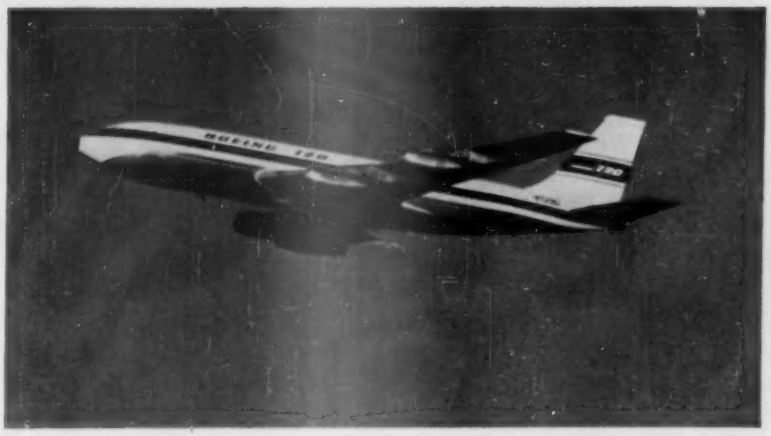
Transport can carry up to 153 passengers in a tourist configuration. Range, with full payload, will be 3,550 mi. maximum.

Plane is 8 ft. 4 in. shorter than the Boeing 707-120, and 45,000 lb. lighter. Top cruising speed is about 615 mph.

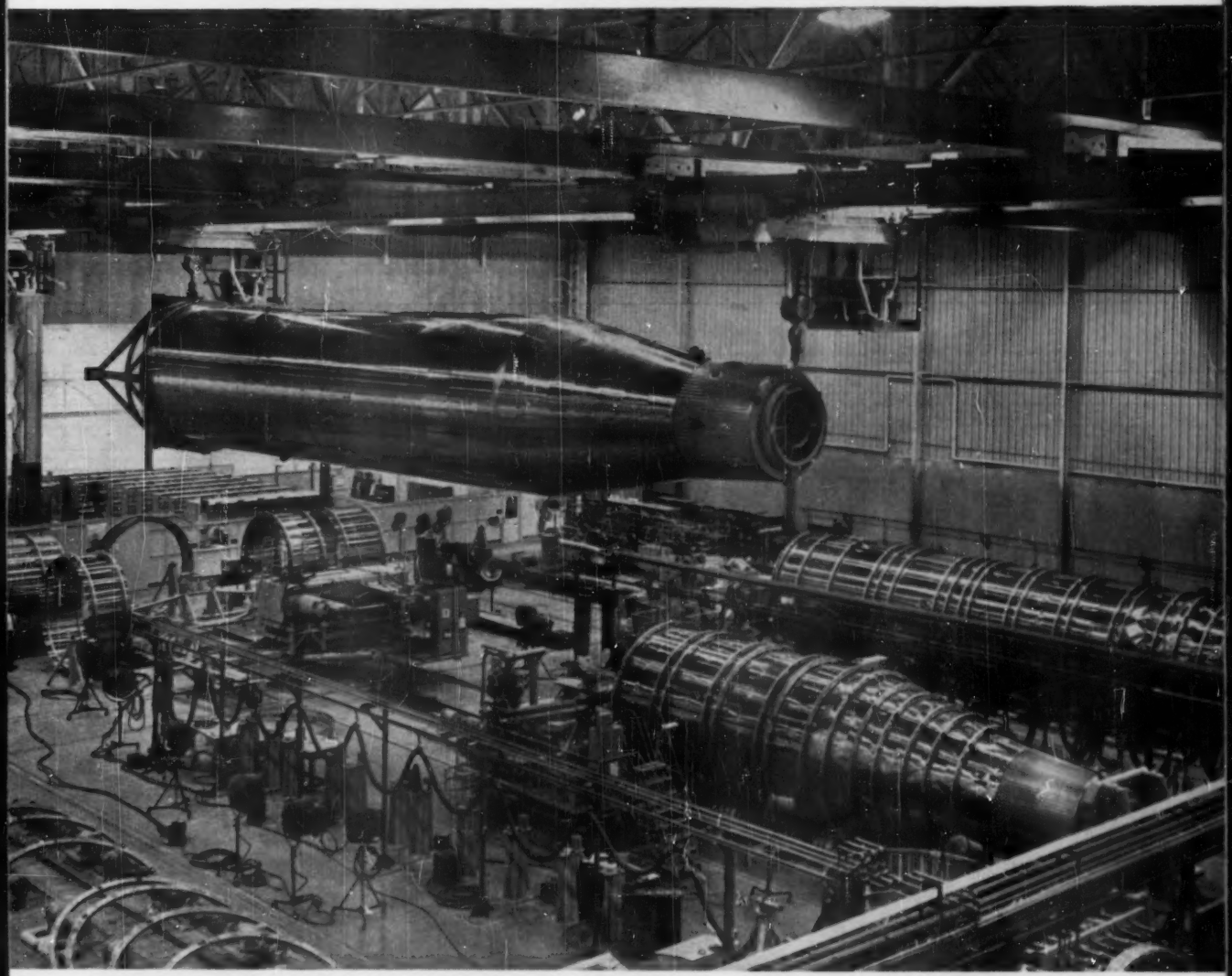
Wing leading edges have been extended, increasing sweepback and adding to low speed wing lift (AW Nov. 9, p. 42).

Boeing 720 Medium Range Jet Starts Flight Tests

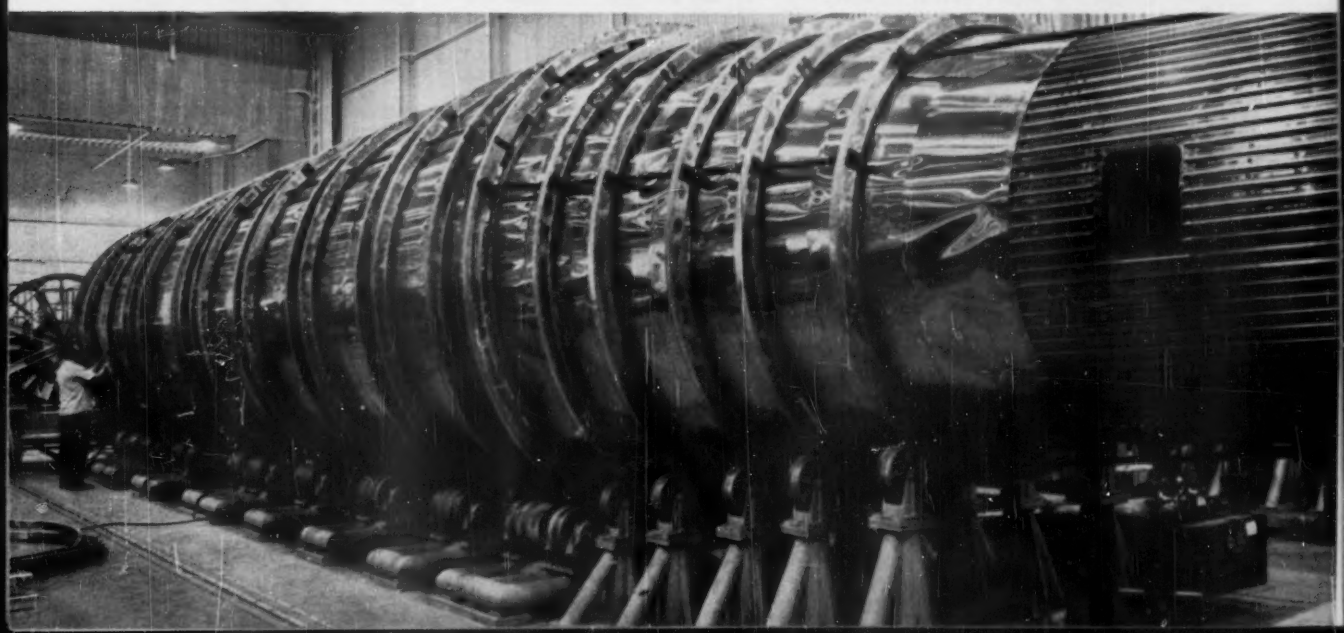
Boeing Airplane Co. has started flight testing of its 707-720 medium range jet transport following its first flight at Renton, Wash. (AW Dec. 7, p. 39). Plane has been ordered by United Air Lines (18 720s); American Airlines (25) and Irish Air Lines (3). Powerplants are four Pratt & Whitney JT3C-7 turbojets; however, the 707-720B model will have JT3D turbofan engines. Modifications of the 720 include redesign of the wing leading edges and rudder and addition of three wing leading edge flaps to improve takeoff and landing characteristics. Eventual modifications may include boundary layer control, scheduled for evaluation at Boeing (AW Nov. 9, p. 43). Company said new modifications probably will go into the production line by the end of 1962.



MISSILE ENGINEERING



COMPLETED Atlas tank is moved by crane at Convair's Astronautics Division, San Diego, Calif. A nearly completed tank is shown below.



Atlas Generates Fabrication Advances

By Richard Sweeney

San Diego, Calif.—Major advances in space age vehicle fabrication have been made by Convair's Astronautics Division through development of techniques required to build the Atlas intercontinental ballistic missile.

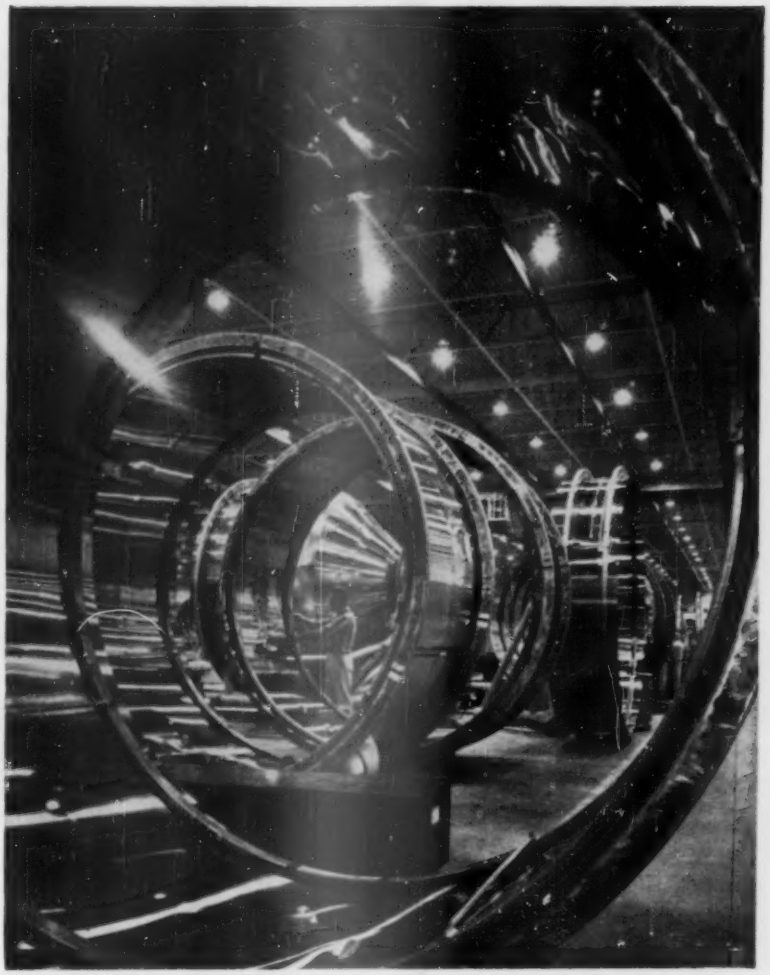
Advances generated by Atlas requirements include:

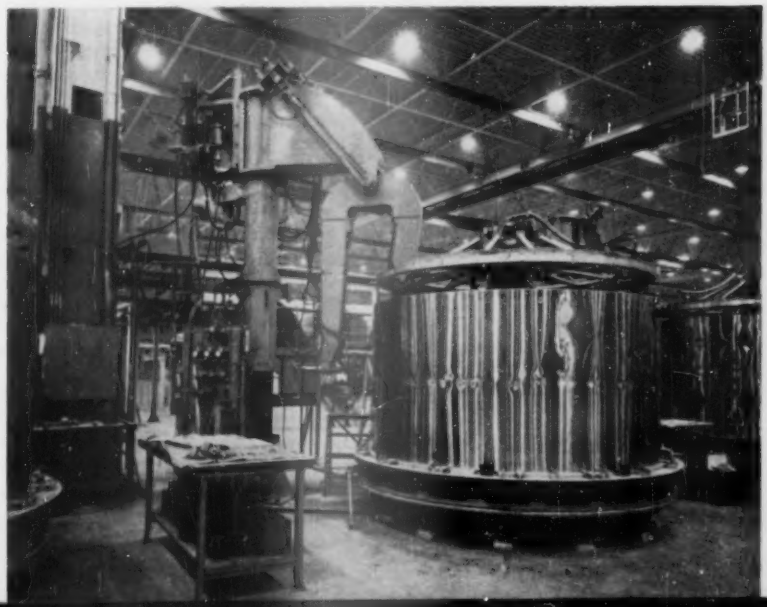
- **Welding techniques** to join very thin Type 301 stainless steel sheet, Atlas primary structural material, including new ways to use the inert gases necessary to prevent oxidation during welding of this type material.
- **Establishment of specifications** for development of machines to form Type 301 material, which is used exclusively in Atlas, to tolerances and shapes without tearing or complete workhardening, in gages as thin as 0.010. This effort has made machine builders aware of space vehicle material problems generally, so that when new materials appear, they will be receptive to accept the required standards.
- **New approach** to machine tool maintenance based on the concept that expense and care is warranted to have processed parts to meet strict quality standards instead of allowing the machine to approach limit tolerances, with parts developing tiny but unrepairable or unacceptable flaws which in some cases would show up only after part has been through final assembly and inspection. Final working would bring out the defect but most of the money already would have been spent on the part—in some cases in excess of $30,000.
- **Materials developed** through metallurgical research which can be processed for ballistic missile environment yet retain precisely predictable electrical and physical properties.
- **Pioneering effort** to orient materials suppliers to observe strict standards that space vehicles require, without the incentive of relying on large production quantities normal in the past. Initially, only one mill was willing to roll Type 301 stainless to Astronautics' plus-or-minus 0.0005 in. tolerance in gages as thin as 0.010 in. Since then, more firms have shown a willingness to meet Astronautics' requirements.

Production Items

Essentially, Astronautics builds Atlases as production items, on a missile-by-missile, job shop basis. This stems from variations in missile equipment required for developmental flight test program and use of the Atlas as a booster for several National Aeronautics and Space Administration projects.

Now, with the missile being deliv-





TANK SECTIONS with inner and outer support rings are above. Welding fixture below is used for joining skin sections. A welding research program is conducted by Convair to keep abreast of new materials, even though they may not be designed into the Atlas.

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ered to USAF operational crews at Vandenberg AFB, Calif., standardization in particular models and configurations is being firmed so that operating personnel will not face many missile detail differences, promoting standardized procedures associated with operational deployment.

In addition to basic production capability, Astronautics' facilities and equipment are keyed to make its Atlas plant a self-supporting development center. Thus, any special missile or component can be built completely in-house. But when production runs are scheduled, parts are subcontracted to specialist firms because Astronautics has only a limited number of each type of machine tool.

Except for some special machine tool requirements, critical to Atlas fabrication, Astronautics uses conventional equipment in fabrication and assembly of the missile.

Astronautics is set up not only to fabricate and assemble Atlas tanks, and perform final assembly of the missile's major subsystems to complete the flight article airframe, but also to produce electronic equipment.

Astronautics designed much of the avionics equipment aboard the Atlas, such as autopilot, programer, AZUSA tracking system transponder, and manufactures a major share of this equipment. Standard electronic parts which can be purchased from vendors are bought, such as transistors, resistors and capacitors, but the circuits in which they are used are Astronautics-designed and built.

Some avionic equipment is installed in Atlas early in its journey down the assembly line, especially instrumentation used in developmental flight test and missiles which undergo extensive static testing in Sycamore Canyon or at Edwards AFB, Calif.

Problems Astronautics solved in meeting Atlas weld requirements included establishment of individual gases or gas mixtures which should be used with each material, flow rates for each application, and a method to introduce the gas through the holding fixture and not contaminating the gas.

Welding Research

An active welding research program is constantly conducted to keep abreast of new materials, although they may not yet be designed into the Atlas. Weld engineers develop the theory necessary to meet new material requirements, then apply it to production in automatic machinery to keep human error at a minimum.

Notable advances have been made in resistance-welding exotic new materials and thin sections of conventional materials. For example, exotic materials include the netic and conetic metals, which have special grain structure orientation for avionic properties. Netic has a high nickel content, while conetic material contains cobalt. Both are flash-plated with gold, then spot-welded and used in miniaturization and microminiaturization of components.

Convair established special more-rigorous specifications within the framework of the existing military welding specifications. Astronautics collaborated with welding equipment manufacturers to meet various Atlas requirements. Primarily, these firms are builders of conventional welding equipment who built special machines to Astronautics' stringent specifications. These requirements are more exacting than generally encountered in production type equipment.

Fusion welding—basic material joined in a continuous seam without introducing additional weld material—underwent concerted research effort. Process now used has a stream of pure helium immersing the top electrode which does the heating to fuse the material, while the iron backup bar is notched to provide a gas passage. This keeps the weld area in helium flow constantly to reduce oxygen contamination.

Bulkhead Welding

Vertical welding technique was developed for 10-ft.-dia. bulkheads made up of several sections, because it is easier than using conventional equipment requiring welders to crawl under holding fixture and assembly. In this previously untried vertical technique, Astronautics manufacturing engineers decided to weld from top to bottom, and developed special schedules of voltages, amperage, rate of head travel, type and flow rate of gas. A helium-argon mixture is used, with critical mix proportions.

Gas impurities was one of the major problems Astronautics met while developing helium welding—welds were being contaminated.

Helium used in Astronautics welding is purer than the basic helium normally available from U. S. Bureau of Mines, the supplier, and each cylinder is tested by running a weld—the only way it can be checked.

Another problem presented was helium's ability to penetrate porous metals, especially the castings and forgings used in valves. The fix was to impregnate the interior of these parts, which carry helium at high pressure, with a synthetic rubber-type material.

Hand-welding is used on some weld parts, principally on the K-Monel ducts which carry liquid oxygen and RP fuel to the booster and sustainer engines.

Hand-welders at Astronautics are certificated by both the company and USAF for six-month periods, by checking sample production-part welds in the

Air brake for a spaceliner

The earth's atmosphere, one of the biggest obstacles to getting into outer space, can be one of our biggest assets coming back. At Douglas we are investigating how we can use its braking effects on rockets returning from deep space trips at far faster than ICBM speeds. Success will allow us to increase payloads by reducing the weight of soft landing systems. This technique also will aid us in pinpointing landing areas. Current reports show real progress. Douglas is engaged in intensive research on every aspect of space planning, from environmental conditions on other planets to the destroyer-sized space ships necessary to get there. We invite qualified engineers and scientists to join us. Some of our immediate needs are listed in the column on the facing page. Please read it.

Arthur Shef, Chief, Advanced Design Section, Missiles and Space Systems, irons out a problem with Arthur E. Raymond, Senior Engineering Vice President of DOUGLAS

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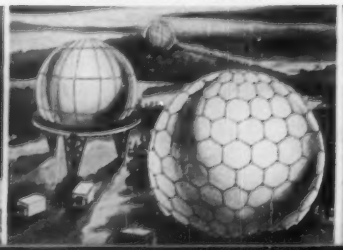

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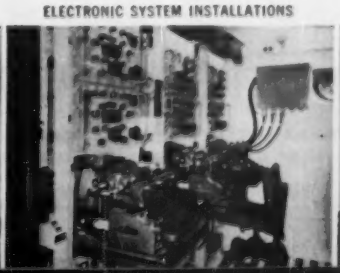

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test laboratory for very accurate results.

Ducts of the K-Monel are the most difficult hand jobs. Astronautics estimates that of all hand-welders on two shifts, only about 10 are qualified to hand weld this material. Proposal to certificate welders by ultimate strength testing of the production K-Monel ducts was quickly killed—the part cost $11,000 by the time it reached the stage where tests would be appropriate.

K-Monel is first formed, then welded, then age-hardened. Because defects do not show until after age hardening, K-Monel parts must be thoroughly cleaned with trichlorethylene solution prior to the start of age hardening. Cracks and breaks can result from fingerprints or pencil marks which are not removed before the hardening process.

It is permissible for pinholes to be filled with soft solder in finished K-Monel ducts, but no major repairs are allowed. Defects mean scrapping the part.

Forming Parts

In early Atlas fabrication development, forming parts from very thin sheets of Type 301 stainless steel proved a problem because this material work hardens rapidly and is not heat-treatable. Once the part is hardened, no further work can be done, and it is scrapped unless it meets specifications.

One of the most difficult parts was the curved forward bulkhead in the tank section, formed from .010 sheets. Early in the program, the material was cooled to −600F using dry ice, then formed. Getting 30 to 40 satisfactory parts out of 100 was considered good.

These bulkheads now are formed on a Cyril Bath stretch former incorporating a "yield control" which slacks off the stretching action just enough to keep the material from tearing when the yield point is approached. Forming die gives the material a wiping motion, helping to get the desired shape without tearing or completely hardening the material. After forming on this machine, parts are in the three-quarter hard condition.

Major Atlas subassemblies are the ring sections of the integral tanks, which Astronautics calls barrel sections. Although most of the tank section is a constant 10-ft. dia., each barrel is welded into circular form on its individual jig due to differences in the gage of each barrel, starting with thin skin near the nose and progressing to heavy skin at the base. After welding, the barrels are kept in internal and external support rings, since the thin material would collapse if left unsupported.

Atlas tank assembly starts at the forward tank bulkheads and works backward. Each of the barrels is stove-piped into the one ahead, a technique calling for close cooperation between structural design engineers and production people.

All parts and components are built into the tank as assembly progresses, barrel by barrel. Fabrication of all large and small parts and components is done with cleanliness comparable with liquid oxygen contact.

Stove-piped barrel sections are resistance seam-welded together, then a row of spotwelds is added on each side of the seam. The welding head travels the circumference three times rather than having all three welds done in one pass. The missile is assembled in a horizontal position and the welding machine travels on a track as the tank assembly gets longer section-by-section.

Most intricate part of all tank assembly is welding the aft tank bulkhead into place. Both the forward tank, which carries liquid oxygen, and the rear, which carries fuel, have a 2-ft.-dia. manhole for cleaning and inspection. To weld the rear bulkhead, a special 28,000-lb. machine was designed with an elbow so that the welding head could be inserted straight ahead through the small manhole; then the elbow is bent to place the head for final weld.

Tank Pressurized

After assembly welding is completed, the tank is pressurized. The internal support rings, which remain in place throughout tank assembly welding, come apart in sections small enough to be removed through the manholes, and are taken out before the tanks are pressurized. External rings remain in place until pressurization is completed.

The pressurized tank is moved to a hydrostatic facility and about 28,000 gal. of demineralized water plus dry nitrogen are used to boost pressure in both tanks to normal maximum pressure levels and a leak check is conducted. Although water is lighter than liquid oxygen and heavier than RP-1 fuel, the total discrepancy is only a few pounds per square inch and the test is considered valid.

Following the hydrostatic test, external support rings are reinstalled on the tanks, manholes are opened and liquid oxygen compatibility cleaning is done for the tank interiors alone.

When the problem of cleaning Atlas tanks to the degree required for liquid oxygen compatibility arose, Astronautics Factory Manager John Hopman weighed several proposals from cleaning specialist firms, but costs and equipment estimates seemed excessive. He figured the closest analogy would be in cleaning of milk tank trucks, so he spent a day at a Los Angeles dairy observing its methods. These resulted in the basic ideas from which Astronautics' present cleaning method evolved.

An Oakite solution is sprayed into the tanks under high pressure to loosen any dirt or carbon particles in crevices. At first a special spray rig was devised which sprayed the interiors at 100 psi., but now a high pressure fire hose is being used. Spray is directed around the tank slosh baffles to avoid damage. The tanks are rinsed at least twice with distilled water, then inspected.

Two inspection methods are used, the water break test and surgical swab method. In the water break test, water is sprayed at low pressure along tank walls, and if proper cleanliness has been obtained, the water will flow evenly down the sides of the tank. In the swab test, swabs are wiped onto sides of the tanks, then put into sealed containers and taken to the laboratory for analysis.

Inspectors, wearing special clothing to prevent tank contamination, are the last to check the tanks. Manholes then are covered by a tight weave cheesecloth.

Following closing, the tank is directed to the final assembly line where tubes, valves, propulsion system and electronics packages are installed. In final assembly, the missile is brought into the configuration specified for it in the contract.

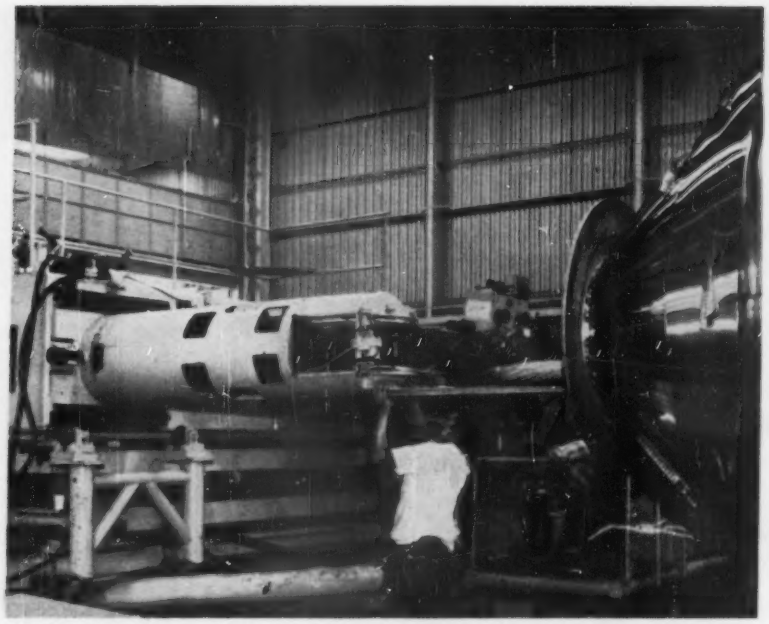
Due to the nature of the developmental program, plus the varied uses to which Atlas has already been put as a booster, it has been said that no two missiles came out the door exactly alike. This is changing now, as operational hardware deliveries start, since military personnel who train with and maintain the missile and will be responsible for launch will not be able to contend with a wide range of missile variations.

After missile final assembly, systems are tested individually. Hydraulic systems are checked in the assembly stands. The missiles then go to the high pressure test area. Here, high pressure systems are tested at more than 3,000 psi. for a functional check of the pneumatics and the pneudraulics (combined pneumatic and hydraulic units).

Leak Checks

After the high pressure run, systems pressures are reduced to 1,000 psi. so personnel can enter the area and perform leak checks. Test procedures assume imminent leaks or weak spots either would blow out or give way sufficiently during 3,000 psi. operation to allow visual detection during 1,000 psi. operation inspection.

Helium systems and titanium storage bottles are checked next and the Atlas is brought back for its major test—the final checkout, during which the missile is run through a simulated countdown using semiautomatic checkout equipment. All systems are operated as they would be at a launch, and the results are recorded on magnetic tape. This record shows whether engines gimbal properly at signals from the autopilot



FIXTURE for welding on the inside of the tank is operated through a small manhole in the bulkhead. Hand welding is used on some weld parts—mainly on liquid oxygen ducts.

PRESSURIZED tank is raised into the hydrostatic test facility; about 28,000 gal. of demineralized water and dry nitrogen are used to boost tank pressure for leak checks.

and if pressures are right in magnitude and time sequence. No liquid flows take place in this final checkout.

Although all pertinent components have gone through individual high pressure test prior to liquid oxygen compatibility cleaning and packaging until they are assembled on the missile, they still get a check in this final dry run. Ducts which would normally carry propellants carry gas instead, undergoing more stringent conditions for leak detection than if the propellants themselves were used.

The missile's telemetry equipment also is checked out insofar as possible—transducers and temperature gages are operated and their output is recorded on tape. After the tape has been read by Astronautics and customer personnel for acceptable operation of all systems, the missile receives a final customer visual inspection and then is placed on the transporter-ejector trailer and shrouded, ready for delivery.

The missile leaves the factory without the pyrotechnics for stage separation and engine ignition, which are not installed until the missile reaches its base.

To help ensure that the final checkout tapes carry proper readings, Astronautics has set up a quality control program which reaches back into the beginnings of missile parts.

Control Areas

D. R. Archibald is manager of quality control, which covers these areas:

- **Inspection of incoming** material at Astronautics plant, of work in progress and end products.
- **Process control,** which develops methods to achieve the desired product standards. This group also develops test plans to get the most answers and best results from quality testing.
- **Quality assurance,** which uses production evaluation testing (PET) of parts off the production line to see that the original Astronautics specifications are being met.
- **Administration,** which provides record service on missiles and serves as a clearing house of information on problems for all Atlas user sites, their causes, and the fixes. Through records, this administrative group also sees that all programed work has been done on the missile, or if not, what remains to be done. Working on an individual missile basis, the group also serves as a contractual commitment compliance checker.
- **Off-site quality control,** which passes on lessons learned from one Atlas base to another in missile handling, malfunctions and the proper procedures for handling deficient pieces of material so that every base will follow the same line. Personnel works with Astronautics and other contractor personnel, rather than the user agency.
- **Outside production** inspection em-

ployes, stationed in supplier plants to help the vendor solve problems arising from Astronautics work. Astronautics feels it is to the mutual advantage of vendor and buyer when they join forces to solve a problem, and the sooner it becomes a team effort to solve the problem, the better, according to Archibald. Buyer representative no longer functions as a "policeman" under Astronautics rules.

Working with the vendor of the spherical titanium helium tanks, Astronautics helped develop a processing technique which increased the yield of tanks from minimum to 90% of total production without any major design changes.

One early and large quality control effort was directed toward thin Type 301 stainless steel sheets. Astronautics wrote specifications for finish, tensile strength, thickness and other parameters. Washington Steel Co., the rolling mill which primarily supplies Astronautics, once shut down its other activities, directing all efforts to deliver a shipment of Convair material. No basic process changes were required to produce Convair steel, just closer tolerance observation.

Washington Steel usually buys its two-ton hot bands from Jones & Laughlin Steel Co., in 0.187 in. thickness, according to Astronautics. Washington selects the best bands from J&L production for Atlas work.

Astronautics usually receives the material in 3,000 lb. to 5,000 lb. coils. Orders are placed according to pounds of a given thickness required. Currently, Astronautics is the only user of Type 301 stainless, and if it rejects a batch, the material must be reworked for any other customer or, in the case of very thin sheet, it is junked.

Samples Tested

Astronautics pulls samples from beginning and end of each coil, sends these to the laboratory for testing. After every 35 ft., another sample is taken and floor-tested for ultimate strength and elongation. Should a sample of material not meet specifications, the entire coil is withdrawn from production use until a complete laboratory test program is completed.

A fairly comprehensive record is logged on each section of missile skin —the heat number, coil number, part number, ultimate tensile strength and elongation data are etched on each section. In early missiles, where skin thicknesses were duplicated, skin sections recovered from missiles without a record could not be identified well according to their position in the structure. Now the specific thickness of the material pinpoints its position in the skin assembly.

This data was used by Astronautics engineering department when the missile was put through a weight reduction program, since data on every piece of primary structure is recorded while detail parts are not.

During fabrication, visual inspection and gage-thickness checks are made constantly, and any defect which can be measured by normal means, such as an optical micrometer or the dial on a needle thickness gage, makes the material subject to Materials Review.

Test samples of welded section are pulled from production material batches, but end pieces are used, rather than the actual parts fabricated for the missile.

Dye Markings

Dye penetrant is used on both sides of parts prior to acceptance. If defects of a specified type are discovered they can be repaired, but other specified defects cause the part to be junked.

Each spotwelding machine is "qualified" for operating limits it must hold. Schedules are individually set up according to type and thickness of material to be welded. After qualification, machines do individual jobs.

Tensile tests of the spotweld, plus visual penetrant tests for porosity, will indicate improper machine settings which can be corrected. Machine output is checked each hour on some work. Machines which handle different types of work, requiring resetting, must be requalified.

Major machines are allowed to run two hours between test samples because of the time element required to set up the machine. Some are limited to one type of work because of the special tooling which they incorporate.

Following usual visual inspections for pits and burns on resistance seam welds and spotwelds, production parts are not tested again until the fabricated missile tank goes to the hydrostatic test facility, where a leak check is performed at about half normal operating pressures.

If a leak is discovered, the Materials Review Group decides if a hand heliarc weld can close the gap adequately.

Biggest cause of worry to inspectors are parts fabricated immediately ahead and behind a faulty one, which passed inspection without the faults being discovered, since a possible fault may be imminent yet still undiscovered.

Ensuring Tightness

At least once daily, inspectors kick and jiggle electrical cable connections and plugs for each machine to ensure tightness.

The triple-distilled water used in the hydrostatic test is pumped through a special system to ensure cleanliness. Once used, water is drained, despite the nine cents-per-gallon cost, to avoid risk of contamination.

Astronautics inspectors work close behind cleaners. Astronautics prefers to hire young men without previous welding inspector experience. They can be trained to Astronautics standards and techniques without having to unlearn any previous experience. Astronautics has only four or five inspectors who can perform final tank inspection and closing.

X-Ray Inspection

Other parts and materials (such as titanium spheres, castings and forgings) not amenable to standard inspection are sent to a special materials laboratory for such procedures as X-ray. Ultrasonic inspection of incoming parts is done before they enter the production pipeline.

Each incoming part, whether Convair or vendor-designed, although qualified after initial testing, undergoes an acceptance test. This holds true for thousands of production parts which are not AN standard (considered as meeting specification when received).

Currently, the ratio of inspectors to production workers in detail parts fabrication is 1 to 12 in. In tank assembly, it decreases to 1 to 10 or 11. A further reduction to 1 to 9 is effected during missile final assembly.

In electronics, which Convair became deeply involved in due to designing equipment to the peculiar requirements of ballistic missiles, constant work is done to advance the state of the art. One example is the AZUSA transponder now being installed as compared with that formerly used (AW Feb. 9, p. 65). The new package is one-quarter the size of the old one.

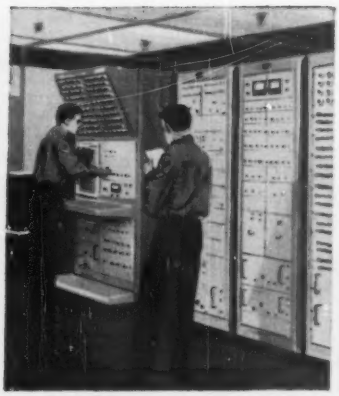
Each electronic part essential for flight safety or mission success undergoes an individual test when received. It must meet not only general specifications, but also must perform within a narrow set of limits established by Astronautics. If the part qualifies, it is labeled with a blue dot. This involves much testing, especially of transistors and comparable units, but saves in the long run by fewer electronic failures in missiles, Astronautics believes.

Astronautics builds up packages such as autopilots and programers. Gyros for these two components are purchased from vendors, tested before leaving the vendor factory and again when received at Astronautics and then undergo an additional seven hours of testing before entering the production line. Three gyros are used in each autopilot stable platform.

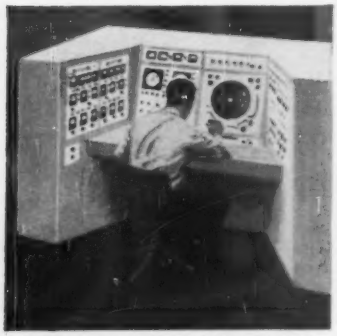
When the platform is built and operated, performance data is logged on magnetic tape as a permanent record. Test inputs are used, which are intended to produce specified output data which can be checked on tape for accuracy and compliance with specifications. Some 40 hr. of running time has

In 1936—air defense by **SPERRY**

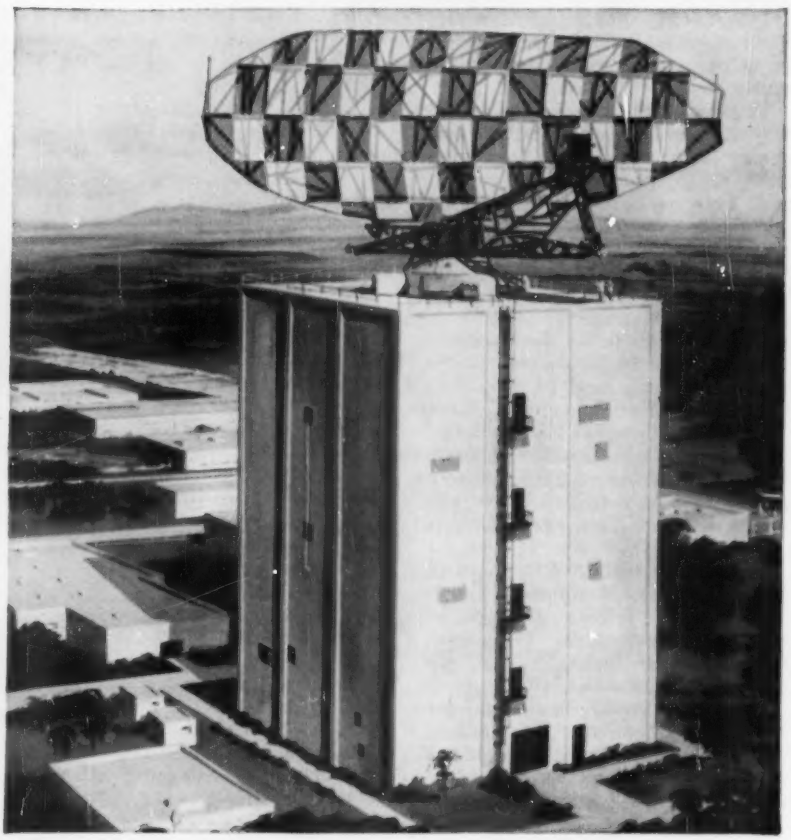
Before the invention of radar, Sound Locators aided the human ear in sensing the approach of aircraft.



HIGH SPEED COMPUTERS housed in tower calculate target information from radar and provide intercept-destroy data.



CENTER OF OPERATIONS for FPS-35 installation is MAJAC—Monitor, Anti-Jam and Control Console.



TOWER OF STRENGTH in U. S. defenses, area search radars by Sperry will be spotted strategically throughout main Air Force defense networks.

Giant Sperry Search Radar To Strengthen U. S. Air Defenses

First fortress-like radar is "on the air" only 19 months after contract

New, high-powered area defense search radars housed in giant concrete "fortress" towers—are taking their place in America's vast chain of air defense systems. The first such tower was constructed at Thomasville Aircraft Control and Warning Station in Alabama.

These radars (AN-FPS-35), developed by Sperry's Surface Armament Division in close cooperation with USAF's Rome Air Development Center, will become part of the Continental Aircraft Control and Warning System which searches out cruise-type missiles and aircraft.

The giant antenna assembly, weighing nearly 70 tons, is situated on a concrete tower 85 feet high and 60 feet square. The radar feeds target position information into high speed computers, which in turn work out involved calculations for interception and destruction of the target by missile weapon systems. The tower houses the full complement of men and equipment necessary to sustain continuous operation. Strategic sites in the U. S. defense network have already been selected for location of additional search radar systems.

This "tower of strength" in U. S. defenses underlines Sperry's advanced capabilities in radar—the result of experience dating back to radar's earliest beginnings and highlighted by many significant Sperry contributions to the science.

SPERRY

SURFACE ARMAMENT DIVISION, *SPERRY GYROSCOPE COMPANY, DIVISION OF SPERRY RAND CORPORATION, GREAT NECK, NEW YORK*

been logged by the gyros when they are incorporated into a stable platform for the autopilot. This package then is tested to specifications.

All electronic canisters are given a two-axis shake-table test at 3g amplitude 200 cps. frequency. The tests are run "hot," with the units tested while normal operating voltages are applied.

Non-Destructive Test

Combination of shake and application of current usually brings out inherent defects of fabrication. Testing is non-destructive, usually far below design limit parameters. Electromechanical components are opened after the shake test for inspection.

Shakers are recalibrated periodically to ensure compliance with established settings. Longest term any test equipment is allowed to be used without recalibration is 90 days, but some equipment is recalibrated every 30 days.

Inspection of the mechanical and structural parts of assembled Atlas are done by one group of inspectors, while the electronic packages, plus the missile portions which have the mechanical, hydraulic, propellant and other systems controlled by the avionic packages, are tested by another group.

When the missile is run through the composite checkout and the tape compiled, it goes to a special group of evaluators for analysis.

Composite Checkout

Composite checkout is semiautomatic; a button is pushed to start the sequence, which continues until the program is completed. During this test, inspectors monitor a number of gages, oscillographs and trace pen recorders, some with emergency stop controls should a malfunction be indicated which might affect safety of personnel or damage the missile.

One problem encountered here is the occasional malfunction of the electronic equipment itself and/or error of the operators. Whenever a problem is indicated during composite checkout, both sides are checked—the missile and test equipment, to pin down the trouble.

If the composite checkout tape is adjudged satisfactory, a final "cleanup" of the missile is accomplished plus inspection by customer personnel. After the acceptance inspection, the missile is weighed, put on the transporter-erector trailer and shrouded.

After the prime mover has been attached to the trailer, a couple of trips around the plant area are made to check that prime mover-trailer is functioning and the trailer driver is competent.

When the missile is shipped, records accompany it. These give a test history of the missile and each significant component.

Illumination in this Binks spray booth is virtually shadowless, enabling painters to work quickly and efficiently.

At Douglas Aircraft, Long Beach, Calif...

90% of all DC-8 painting done in 3 Binks spray booths

A whopping 151-ft. Binks dry-type spray booth accommodates the main fuselage section of a DC-8 Jetliner. This is the largest of three booths used for priming and painting. Entry is through large roll-up doors at each end of the booth. Hanger-type doors along one side of the booth provide a 100-ft. clear opening for easy roll-in of other large assemblies.

Twelve powerful 20,000 cfm exhaust fans insure positive removal of fumes and overspray. Intake and exhaust air is filtered to prevent dust entry and keep exhaust stacks free of paint pigment.

Production line requirements

Design and installation of these spray booths combined the talents of Douglas production personnel and Binks spray painting engineers. Of prime consideration was the need to integrate the painting operation into the production line. Capacity and reliability were a must as a jam-up in painting would seriously hamper other production steps. The dependability and efficiency of Binks spray guns also contributed to an assurance of smooth-flowing production.

Investigate this finishing bonus

In addition to bringing a wealth of experience to every finishing problem, Binks engineers bring a complete line of standard manual and automatic equipment as well as electrostatic and airless spraying units. They have no "special" process to sell. This can mean dollar savings to you . . . does mean a finishing system best suited to your requirements. **Call, wire or write today.**

Ask about our spray painting school
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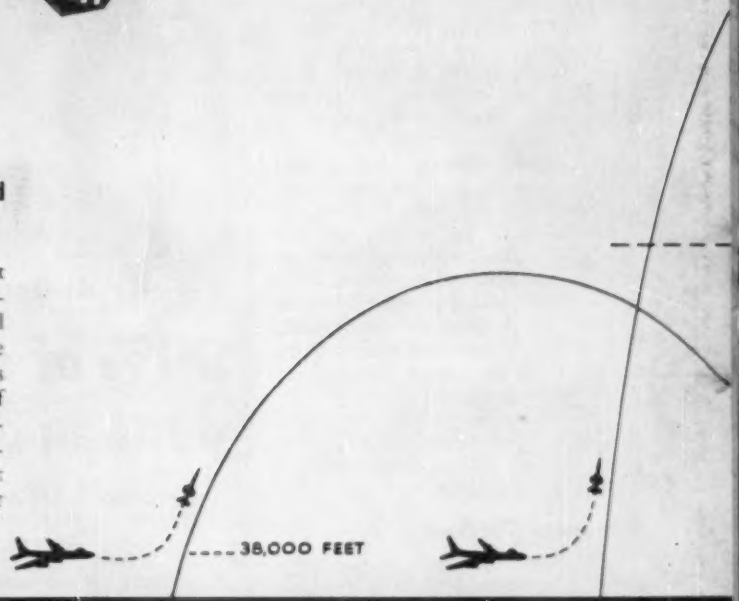
Honeywell is developing an advanced self-adaptive flight control system for test in manned space research vehicles

Honeywell, under sponsorship of the Wright Air Development Center's Flight Control Laboratory, is currently developing an advanced Self-Adaptive Flight Control System for future hypersonic weapons systems. This system is being designed to perform the critical task of automatic control and stabilization throughout the entire flight profile, including integration of aero-dynamic and reaction controls. It is typical of those systems to be evaluated for future flight test in the X-15.

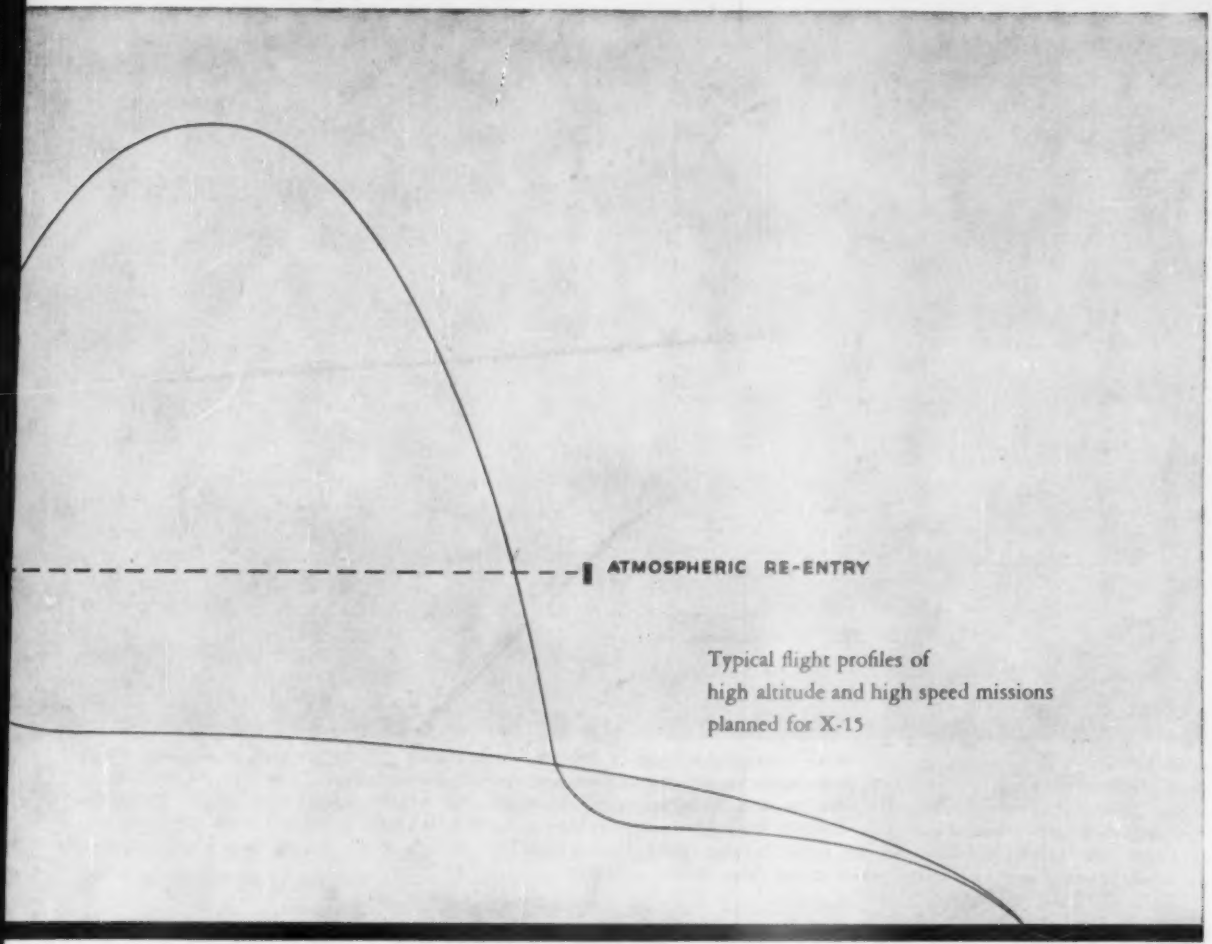


FROM SEA LEVEL

The Honeywell Self-Adaptive Autopilot is designed to deliver optimum performance for every type of flight vehicle

The simplest, most reliable automatic flight control system yet designed, the Honeywell Self-Adaptive Autopilot operates independently of air data information and complex gain scheduling. Adjusting itself in response to its own performance, it is unaffected by changes in aerodynamic characteristics.

The advantages of this highly versatile system relate directly to stringent military requirements and are detailed on the opposite page.



Typical flight profiles of
high altitude and high speed missions
planned for X-15

TO SPACE

Simplicity—Needs no air data information for gain scheduling—is not significantly affected by design modifications in aircraft, asymmetric loading or center of gravity changes—is easily mechanized and needs little tailoring to specific vehicles—is 45% smaller and lighter—requires 50% less power.

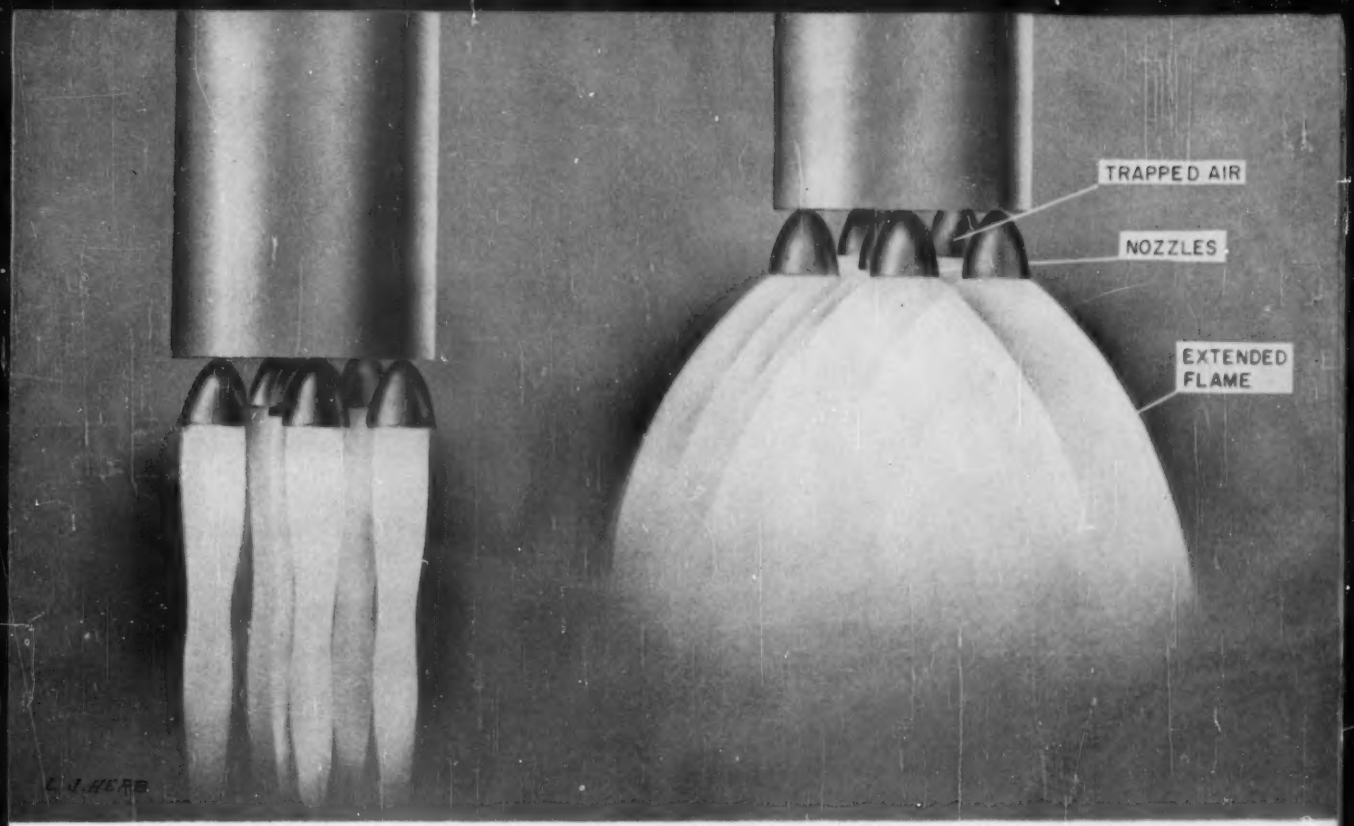
Reliability—Provides major reduction in required components, sub-assemblies and wiring—uses solid state amplifiers and switching logics.

Economy—Assures significant cost reductions through low initial cost of design and development, and simplified logistics, training and maintenance.

Versatility—The Honeywell Self-Adaptive Autopilot System can be quickly adapted without major modifications to air vehicles of all types—business aircraft, helicopters, drones, supersonic fighters and bombers, missiles and the latest hypersonic research vehicles. Having previously gone through highly successful tests in the F94C, the system is now undergoing flight tests in both the supersonic F101A and "light-twin" Cessna 310 aircraft—impressive evidence of its wide range of adaptability. To learn about fitting it into your plans, call or write Honeywell Aero, Dept. 671, 2600 Ridgway Road, Minneapolis, Minnesota.

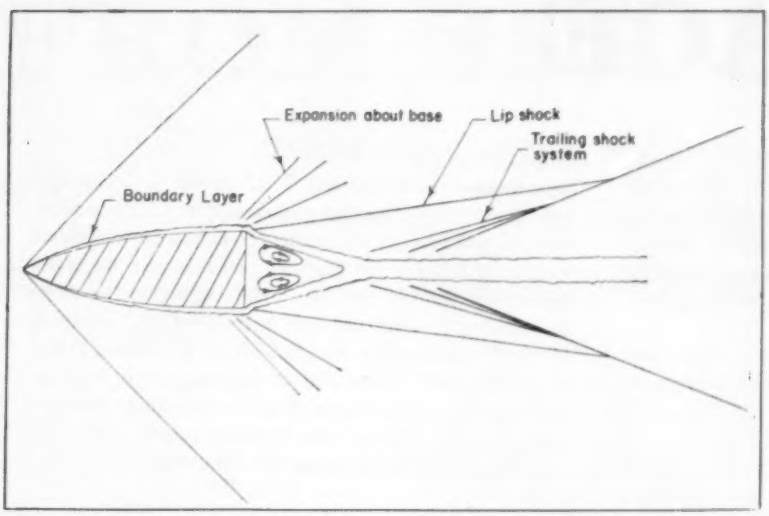
Honeywell

H Military Products Group



BALLOONING of rocket exhausts at high altitude has caused difficulties with missiles and space vehicles powered by clustered rocket engines. Exhaust pattern on a hypothetical cluster under near-space conditions is shown in the second drawing from left; sea level pattern is at left. Spreading of the exhausts greatly alters the flow conditions around the missile base and the exposed rocket engine parts. Air trapped near these parts is heated rapidly to very high temperatures and has been responsible for engine failure and missile structural failures. Rear view looking directly into the rocket nozzles (third drawing from left) shows how the exhaust flows interact. Strong but unsteady pressures have been created which caused thrust vector oscillations.

Unexpected Rocket Problems Boost Test

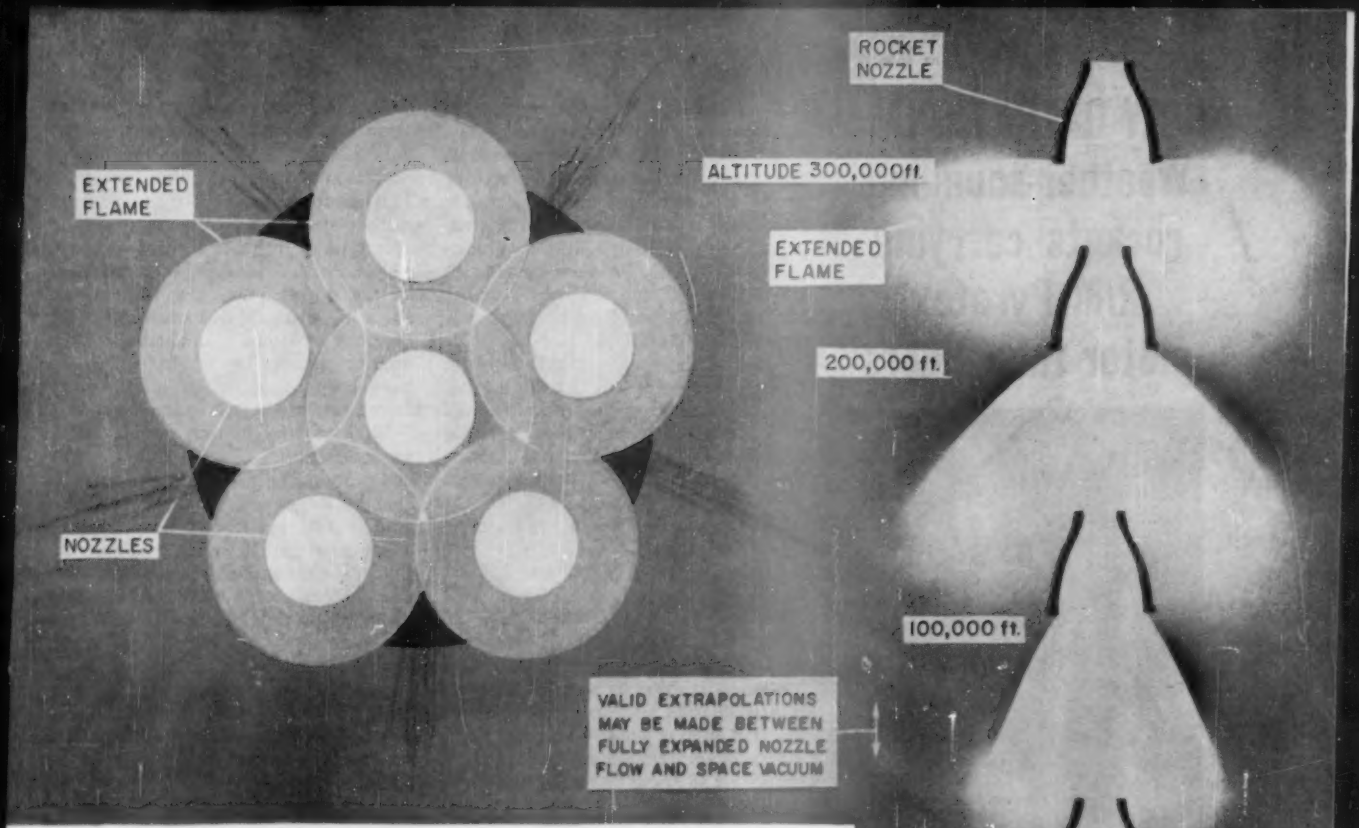


DEAD AIR REGIONS and turbulent mixing zones behind a simple body of revolution are shown above. If a single rocket nozzle and exhaust are added behind such a body, it is almost impossible to predict exactly where the dead air and mixing regions will be located at all speeds and altitudes. A cluster of engines behind a missile makes this prediction task almost completely empirical.

By J. S. Butz, Jr.

Tullahoma, Tenn.—Rocket engine operation at high altitude has been an unexpected source of major trouble in the U.S. missile and space programs, and ground facilities for testing rockets under near-space conditions are currently in great demand.

The altitude performance of most rocket engines in use today was predicted on the basis of extrapolations from sea level test data. It has been shown through recent ground testing at low ambient pressures, much of it at USAF's Arnold Engineering Development Center here, that the original thrust, specific impulse and other performance predictions have been in error by as much as 10 to 15%. It is believed that performance uncertainty of this magnitude has contributed significantly to the failure of some of the U.S. deep space shots in which the vehicle guidance systems were trying to hold cut-off velocity and orbit injection positions to percentage errors of 1% or less.



EXHAUST FLOW shapes from a typical high expansion ratio rocket nozzle at various altitudes is shown at right based upon studies made by the Air Force at the Arnold Engineering Development Center, Tullahoma, Tenn. Reverse flow around the lip of the nozzle at 300,000 ft. has impinged on the missile base in some cases and caused structural failure. Only remedy without major modification has been to add heavy fire walls at the missile base. Full study of altitude rocket performance is in progress at AEDC.

Facility Needs

Other problem areas where AEDC has substantially contributed to finding that extrapolations from sea level and small scale information have not been accurate include:

- **Interactions between exhaust flows** from clustered engines and between the engine exhaust and the airflow around the base of the vehicle. Slow moving or stagnant air around the rear of the vehicle has been heated by the engine exhaust to much higher temperatures than predicted, causing failure of the missile structure in some cases.
- **Nozzle durability and life** has been below estimates, especially for uncooled plastic nozzles for solid fuel rockets. Convective cooling action of air flow around the missile at high altitude has been much lower than predicted.
- **Chuffing at altitude**, which did not occur or was corrected during sea level tests. This sporadic burning has persisted on occasion for three minutes after a solid fuel rocket has been shut off, delivering as much as 1% of the total impulse of the engine. Chuffing of this nature has been powerful enough to push a "burned-out" rocket stage forward and into collision with the upper stages coasting ahead of it. While the force of such collisions is small, it is enough to alter trajectory.
- **Ignition characteristics** of both liquid and solid fuel rockets at altitude have not been predictable. Many ignitors have failed to work altogether, and most engines have required a cut-and-try altitude test program to bring altitude starting performance to an acceptable level.

Testing of rocket engines under simulated altitude conditions was not begun on a large scale in the U. S. until about a year ago, and most of it has been performed at AEDC. A major reorientation and requirement of this Air Research and Development Command facility is about to near completion by the operating contractor, Aro,

For photographs showing some of the conditions described in this article during a Thor firing, see pages 60-61.

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Motor-tube liners for new weather-sounding rockets are R/M Pyrotex asbestos-phenolic tubes. These liners withstand a direct rocket blast for periods up to 90 seconds.

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Test R/M materials without tooling costs. We can supply your testing program with molded billets or tubes from which you can machine your prototype parts at the cost of the materials alone—*no charge for tooling.* What better way to learn the merits of an exciting new material for nozzles, exit cones, fins, nose cones, etc.? Phone, wire or write your requirements.

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Inc. Originally, the prime purpose of this facility was to test turbojet and ramjet engines at subsonic, transonic and supersonic speeds through all stages of their development from boilerplate prototypes of small components to complete engines installed in the vehicles they power. This has been possible on relatively small missiles such as the McDonnell Green Quail decoy missile powered by the GE J85 turbojet.

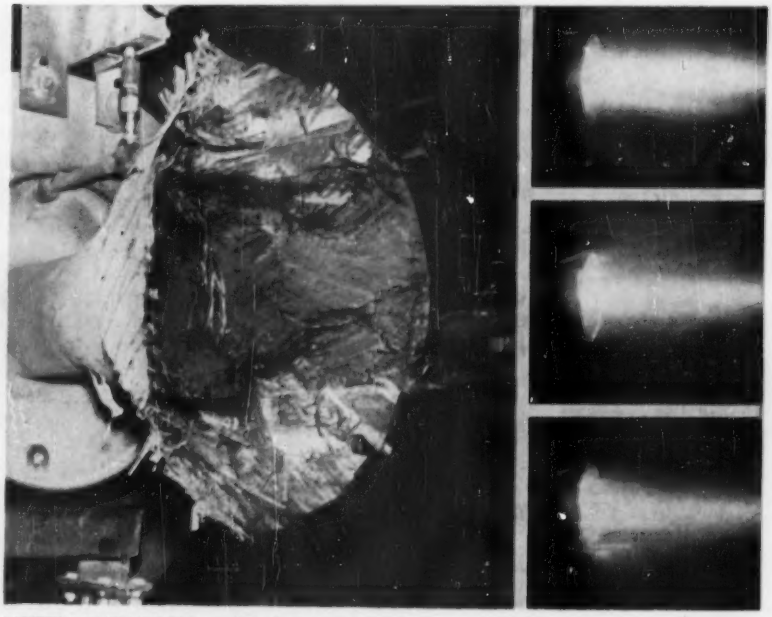
Most of the engine test facilities at AEDC have been modified in the last year and one-half so that rocket engines could be tested under realistic altitude conditions up to 150,000 ft. During the first half of 1959, rocket engine work constituted about 50% of the center's work, and during the second half it was about 75%.

There are seven engine test cells at AEDC which vary in diameter from 12 to 20 ft. and in length from 19 to 75 ft. Test Mach numbers up to 4.0 are now possible, and tests have shown that Mach 7.0 is feasible without temperature simulation. Temperature range in the cells now is from −120F to 800F. Seven large compressors are used to supply air to these test cells, and eight compressors are used to exhaust the air contaminated by the engine exhaust. Interconnections between the compressor units allow a wide spectrum of operating conditions to be simulated. Rocket engines up to 50,000 lb. thrust have been tested so far in these cells.

A new type of diffuser was designed by Aro engineers so altitude pressure conditions could be maintained in the test chamber even when the rocket engine under test was not operating. This made it possible to get realistic altitude start data on the engines. The new type of diffuser has an auxiliary ejector which is located inside the main ejector operated by the test engine when it is firing. If this auxiliary ejector operated by steam or air had not been used to evacuate the test cell, it would have been necessary to install many more units of exhaust compressors.

Most of the diffusers in use today to create altitude conditions around the exit portion of a rocket nozzle are operated by the exhaust from the test engine so that sea level conditions exist when the engine is shut down. Installation of the auxiliary ejector-diffusers and systems for storing and feeding rocket propellants to the chambers were the main modifications needed to prepare the test cells for rocket work.

Another major unit at AEDC used for high altitude rocket testing is the Propulsion Wind Tunnel. The transonic section of this tunnel has been in operation for several years, and the supersonic section is nearing completion. A series of synchronous motors totaling 216,000 hp. moves the air in these tunnels. Large scale models of the biggest U.S. missiles can be tested in the closed circuit transonic tunnel with rocket engines running. A scavenging scoop behind the rocket engines



NOZZLE DURABILITY at altitude has not been up to expectations and apparently has contributed to the failures of some solid fuel rockets with plastic nozzle liners. Test above in an AEDC altitude test facility shows a nozzle failure which occurred at only a small percentage of its intended life. Experimental program at Tullahoma has shown that currently-used heat transfer data at altitude has had significant errors, and convective cooling of nozzles is not as effective as had originally been predicted.

THE SHAPE OF THE FUTURE...

The wing is free to do its job

because...

the engines are in the right place

Here is *the* aircraft design of the future—with its clean, uncluttered wing and *rear-mounted* engines. Among its many advantages:

- Wing has higher lift and lower drag—assuring superior airfield performance and better high mach characteristics
- Full-span leading edge lift devices and uninterrupted flaps
- No tanks or fuel lines in turbine disc areas
- Better performance margins and unique payload/range capabilities
- Greatly reduced cabin noise—throughout
- No handling problems in critical "engine out" situations
- High-set engines practically eliminate debris intake risk
- Simpler maintenance from better systems access
- Reduced engine mounting structural difficulties

With all these—and many other—advantages, *rear-mounted* engines represent a momentous step forward in jet age design.

For complete data, contact Christopher Clarkson, U. S. representative, Vickers-Armstrongs Ltd., 10 Rockefeller Plaza, New York 20, N. Y.

VICKERS VC 10

Four rear-mounted Rolls-Royce Conway By-Pass Turbojets

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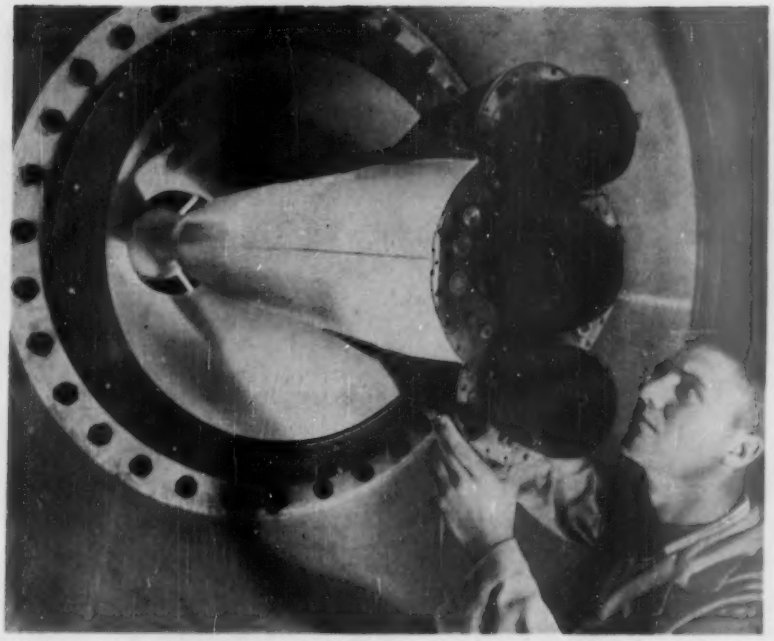


SMALL SCALE MODEL of the USAF-Convair Atlas ICBM is being prepared for hot exhaust tests in a tunnel at Tullahoma. Tiny engines used in these tests can be burned steadily for extended periods to ease the data gathering problem.

removes the air containing the propellant exhaust products, and this air is cleaned and returned to the system. Full scale versions of the smaller missiles, such as the Army's Sergeant, have also been tested.

Tunnel Data

Data from this tunnel, which is unique in the U.S., has been invaluable in the study of the flow interactions around the base of guided and ballistic missiles. Even though the maximum test Mach number of the tunnel is 1.6 it provides accurate information in the critical and unpredictable transonic region and can give a good indication of flow conditions at high supersonic speeds.

Small scale supersonic and hypersonic data is provided by seven tunnels of the Gas Dynamics Facility at AEDC. Two of these can reach Mach 20.

Performance Measurements

The first attempt to make precision performance measurements on fairly large rocket engines at AEDC was in connection with tests of the third stage engine for a Thor-Able lunar probe. A number of interesting results were obtained from the tests of this 15,000-lb. thrust engine, and a number of problem areas uncovered. It was found that the predicted thrust coefficient versus area ratio curves for nozzle performance at high altitudes were in error by 10 to 15%. All basic rocket performance and design parameters were in turn affected by this error in thrust coefficient. The error was primarily due to incorrect predictions of the flow expansion to be expected under low ambient pressures. Exhaust flow turbulence and Reynolds number changes along the nozzle wall often caused separation and kept the exhaust from filling the nozzle as expected. In some cases, the flow ballooned out enough to move ahead of the exit plane of the nozzle.

It is possible to use data from a 15,000 lb. thrust engine and extrapolate for the design of much larger engines. Therefore, one of the high priority programs at AEDC has been to get accurate and complete thrust coefficient versus nozzle area ratio curves at the higher altitudes. Area ratios of 18, 24 and 40 have been investigated, and others are in progress to get more points on the curves. Several different ratios of propellant specific heats are also being studied.

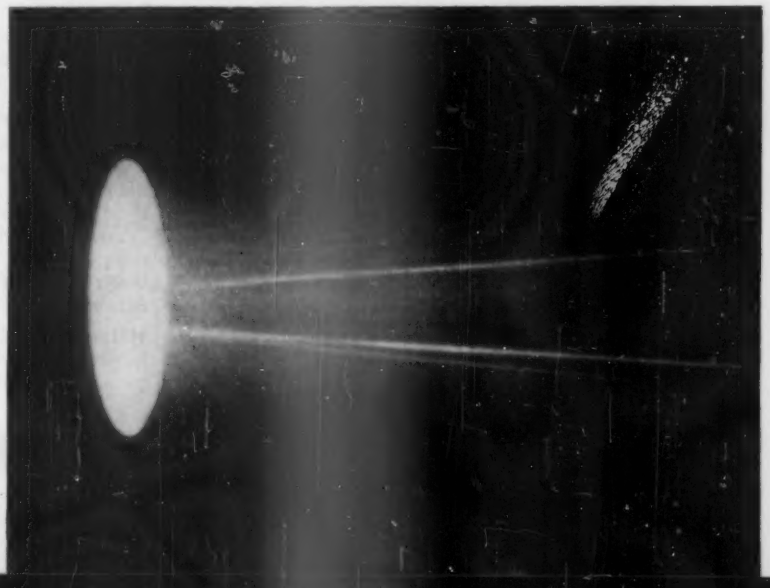
Thor-Able Tests

During the tests of engines for the Thor-Able third stage, it was discovered that some of them chuffed after burning out at altitude when they didn't at sea level. While no exact cause was found for this performance it is believed that these characteristics contributed to it: low pressure burning characteristics of the propellant, sliver characteristics of the grain design which leaves small portions of the propellant on the case wall after burnout, thermal conductivity of the case and nozzle structure and the ignition source provided by the hot graphite nozzle. Prevention of high altitude chuffing requires a decidedly empirical approach today.

Durability of nozzles lined with various plastic materials was found to be below the design objective during these Thor-Able tests. Light nozzles were originally used to get the best possible vehicle mass ratio. However, these altitude tests showed that sea level information on the thickness of insulation required for a given mission was in definite error.

One of the most involved problems of high altitude missile performance concerns the interaction of the exhaust flow and the air flow around the mis-

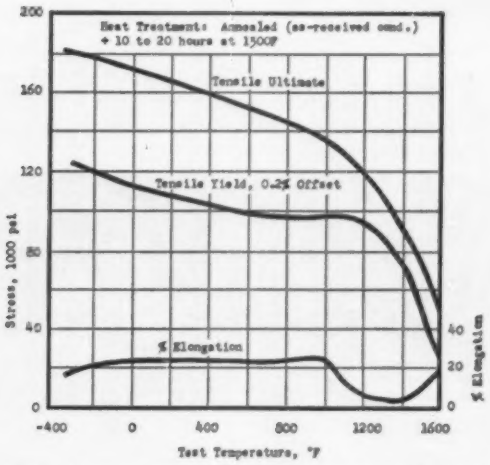
CHUFFING or unprogramed burning after engine shutdown at high altitude has been experienced with some solid propellant rockets. Exhaust pattern above is typical of such burning. Sea level engine tests will not reveal altitude chuffing problems. In some cases, chuffing has lasted up to three minutes after engine shutdown.



Space cold

Re-entry hot

INCONEL "X"... when you want sheet with range



Typical tensile properties of age-hardened Inconel "X" alloy sheet. Note strength at high and low temperatures. Much higher strengths are the additive effects of cold work and age-hardening.

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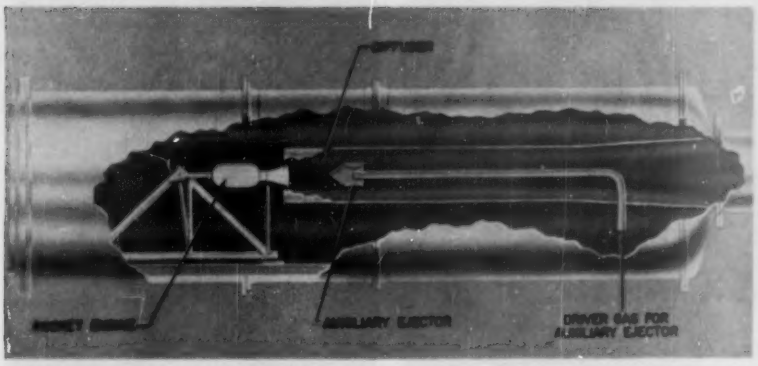


AUXILIARY EJECTOR inside the diffuser-ejector used for rocket test work at Tullahoma is operated by steam or air and allows near vacuum to be pulled around the rocket under test when it is not operating.

sile. This problem is aggravated when a vehicle uses clustered engines. Stagnant or slowly moving air at the base of a vehicle in some instances has been heated to such high temperature that heavy fire walls and deflectors were added to prevent structural failure. On one large missile, a 600-lb. fire wall was necessary. Typical of the unexpected results obtained during tests at AEDC is the fact that the lightest and most serviceable flame deflectors added to one missile were made of stainless steel or even carbon steel rather than modern high temperature plastics which were originally judged to be the most desirable.

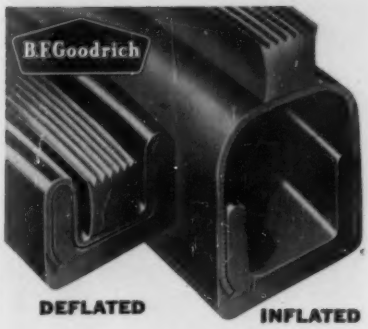
Placement of the exhausts for auxiliary power units such as the turbine engines for turbopumps and vernier control engines has also raised unexpected problems. On several missiles, these exhausts were inadvertently located in dead-air regions so that the hot exhaust gases collected behind the missile instead of being swept away by the main air flow over the vehicle. Large scale model tests at AEDC have been instrumental in mapping the unusual pressure distributions which occur behind cylindrically shaped missiles at some altitudes and speeds.

Base pressure distributions are almost impossible to predict accurately today if the missile uses clustered engines. As the missile goes to altitude, the rocket exhausts begin to balloon out and there is no way to keep them from impinging strongly on each other. Depending on the arrangement of the engine cluster, the shape of the missile base and a number of other factors which are not completely understood, the total exhaust pattern can become unstable at some forward speeds and altitudes. Problems created by the exhaust flow instability include a rapid shifting of the thrust vector, which should be included in the initial design of the missile so that it will be certain that the guidance system can overcome it.

Navy to Use Balloons In Cosmic Ray Tests

Washington—Navy plans to launch two Skyhook balloons at sea with payloads to measure high energy cosmic rays at 100,000-120,000 ft.

Skyhook balloons will be launched in the Caribbean from the aircraft carrier USS Valley Forge with 2,500-lb. payloads which will include 800-lb. blocks of emulsion sheets to measure cosmic rays. The 10 million cu. ft. balloons were developed by Winzen Research, Inc.



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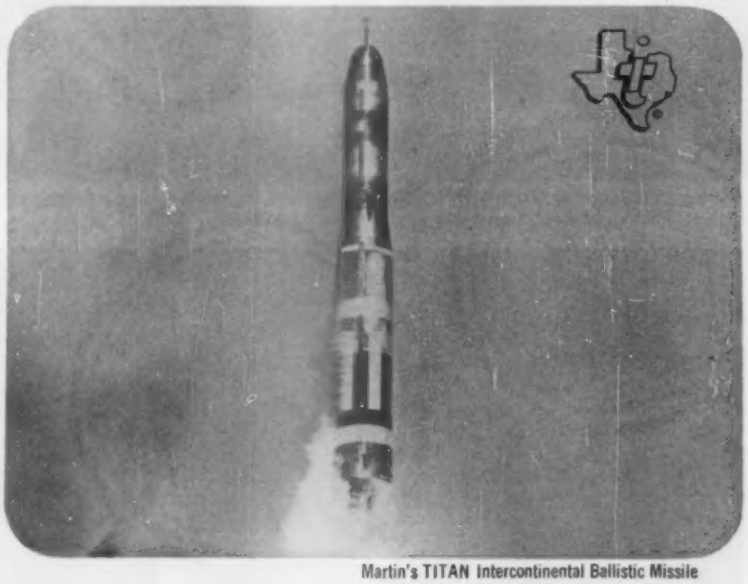

Martin's TITAN Intercontinental Ballistic Missile

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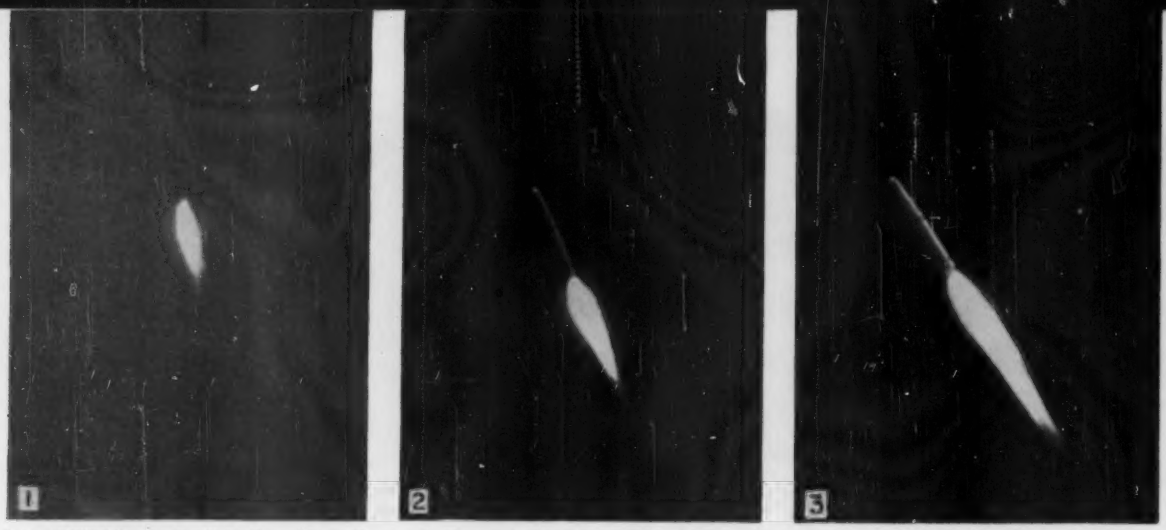
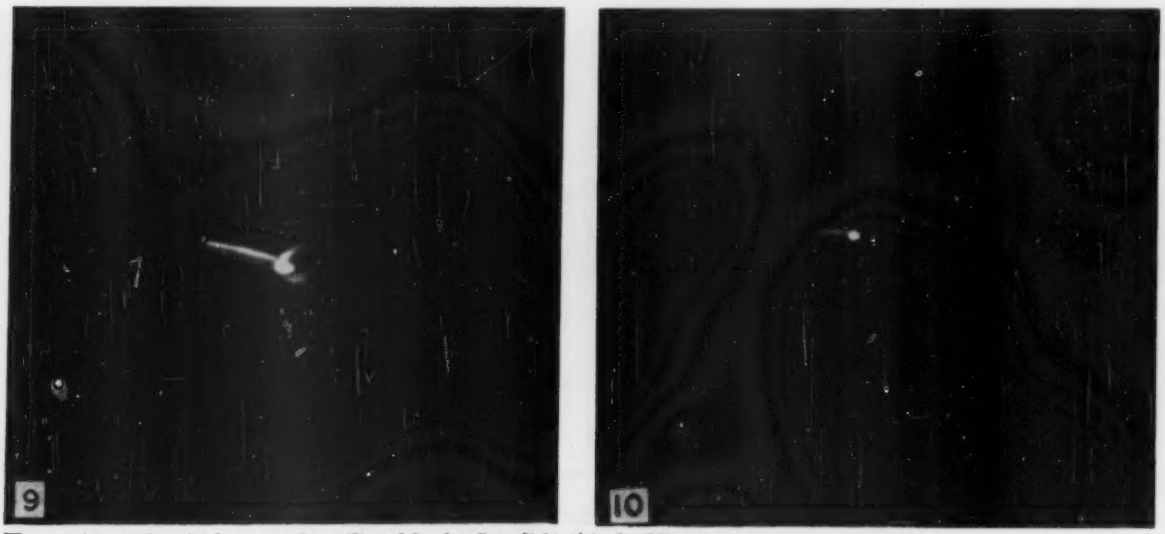


Thor IRBM begins its flight from Cape Canaveral, Fla.; note lengthening of exhaust pattern (photos 2 and 3) as the missile climbs.

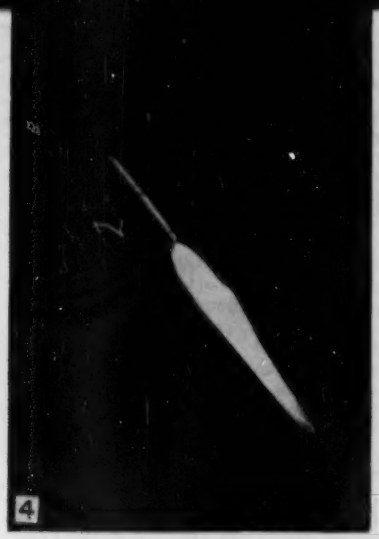
Flight Tracking Photos of Thor IRBM Show

Shock pattern begins to take a definite diamond form and the exhaust flame lengthens even further. Photo was selected from one of about 5,000 frames taken of the flight.

Series of flight tracking photos shows the changing exhaust patterns of an Air Force-Douglas Thor intermediate range ballistic missile as it climbs to altitude on the Atlantic Missile Test Range. Photos were taken by a ROTI Mk. 2 (Recording Optical Tracking Instrument) designed and manufactured by the Electro-Optical Division of Perkin-Elmer Corp., Norwalk, Conn. The equipment is operated by Radio Corp. of America personnel. Photo series was made from the Melbourne Beach, Fla., ROTI site, about 30 mi. south and slightly west of the launch site at Cape Canaveral. Ballooning and lengthening of the exhaust can be seen in the pictures at top of the page; note how a diamond pattern in the exhaust appears as the missile nears the design altitude of the



Thor engine reaches the burnout phase (9) and levels off at flight altitude (10) prior to nose cone separation.

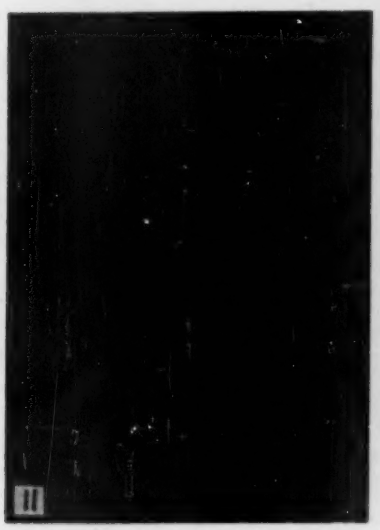


Shock wave begins to affect the flame pattern (4) as noted by appearance of a bulge on the upper side of the plume (5 and 6).

Exhaust Patterns

rocket nozzle. At the extreme altitude, just before nose cone separation, the diameter of the exhaust flow is much larger than the missile body and the leading side of the shock diamonds in the exhaust are luminous. Flight testing of large ballistic missiles such as the Thor has done little more than reveal the engine operating problems present during high altitude operation. Limitations on the amount of telemetered data which can be obtained, short operation time and the lack of close observation has made it difficult to completely understand and correct high altitude engine problems through flight testing. Propulsion wind tunnels and low pressure engine test cells are being modified to allow the ground testing of rockets under high altitude conditions (see p. 52).

Diamonds become quite evident as the Thor continues its climb to burnout. At peak altitude, shortly before burnout, the exhaust flow diameter is larger than the missile body.



Complete Thor burnout is shown in photo 11 and ionization of the atmosphere starts in photos 12 and 13.

Kistiakowsky Cites Basic Science Need

National Aeronautics and Space Act of 1958 assigns to the President the responsibility to "survey all significant aeronautical and space activities, including the policies, plans, programs and accomplishments of all agencies of the U. S. engaged in such activities," and to "develop a comprehensive program" of air and space activities to be conducted by the various agencies. This program is determined to a great degree by the attitude of the President and his scientific advisers toward the need for, usefulness of and urgency with which space exploration should be pursued.

Dr. George B. Kistiakowsky, the President's special assistant for science and technology, heads the Scientific Advisory Board that provides the President with the bulk of the information on which his space policy decisions are based. Dr. Kistiakowsky recently outlined the Administration's attitude more clearly than either he or his predecessor, Dr. James R. Killian, Jr., has since the launching of Sputnik I. Because of the influence of this thinking on U. S. space programs and the consequent affect on industry, AVIATION WEEK is publishing in full Dr. Kistiakowsky's speech on the need for basic science in our society.

A popular and widely-used dictionary calls "knowledge obtained by study and practice," a definition that applies equally well to technology, and yet the two things are rather different. It is small wonder then that current Russian successes in rocket propulsion and some other technological skills, dazzling though they may be, are often described by the press as "scientific" superiority and thus are given deeper significance than they deserve.

We may be sure that Russian colleagues in basic science would be the first to discriminate between their own technology in rocket matters, and, say, the intellectual concepts of cosmic space that still must be resolved before they- or we—can claim major new accomplishments in creative scientific thought about the universe.

On the other hand, we must accept as a fact of life that for the time being, the USSR is ahead of us in some spectacular aspects of rocketry, just as we of the West are ahead of them in many other technological areas. Soviet scientists have the advantage in the weight of the payloads that their engineers are able to hurl into space. But this weight advantage stems from the earlier start of the Soviet development of very large rocket boosters that were deemed necessary for their intercontinental ballistic missile program.

Because of the relatively advanced state of our nuclear warheads, however, we were able, after a much later start, to develop an effective ICBM using a smaller rocket booster. There is no military advantage accruing to the USSR in the field of long-range ballistic missiles by virtue of her larger rocket vehicles, but their size enables the USSR to achieve some "spectaculars" in space. Meanwhile, our satellites, launched with the comparatively small rocket boosters derived from our earlier short-range missiles and equipped with sophisticated instrumentation, have already produced major scientific accomplishments in outer space. Let me list a few of them:

- **The Van Allen radiation belts** were discovered and mapped; they were shown to consist of corpuscular radiation trapped in the earth's magnetic field as predicted by Christofilos.
- **The earth was shown to be** pear-shaped, and so geodesy took a major step forward.
- **The upper atmosphere** was shown to be much denser than believed; the density was found to fluctuate, and this was correlated with the fluctuations of the intensity of the solar microwave radiation at 10.7 cm. wave length.
- **Solar radiations in** the ultraviolet and X-ray regions of the spectrum were measured.
- **A source of extreme** ultraviolet radiation —around 1,300 angstroms—was discovered near Virgo, the intensity of which is quite unexpected and may be of major significance to astrophysics.

There are other interesting findings, but the point which I want to make is already clear: USSR scientists, who also made important discoveries in outer space, cannot claim supremacy in outer space sciences.

This consideration of the now very fashionable activities in outer space leads me to a general conclusion: It is essential to be aware of the distinction between science —the understanding of man and the world he lives in—and technology, which is the application of this understanding to the needs of mankind.

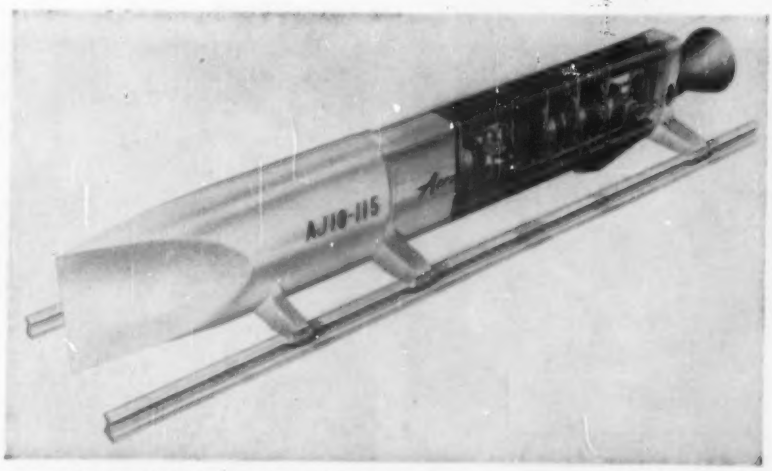
It is not the things of technology but the ideas born of scientific understanding that have brought about the revolution in man's thinking about his way of life. But it is the products of technology that make life easier, give time for education and hence an opportunity for intellectual growth among the broad masses of the population —and should make life happier for some of us, at least.

It may be said that scientific research enriches our understanding, while development and engineering give us the new things that are so vitally important for our material welfare and progress. In the public mind these matters are badly mixed up and basic research is frequently seen as only the less useful, long-hairish appendage of technology. If this misconception becomes ingrained, then as night follows day, both science and technology will suffer.

History of Technology

Let us consider for a moment some facts about technological developments which I have selected almost at random from various fields. The history of modern development of nuclear power stems directly from Fermi's experiments on the reactions of neutrons with heavy atomic nuclei which were a part of abstract research in nuclear physics during the late 1930s. The television industry had its beginnings in basic research on thermionic emission and in abstract studies of photoelectric effect. In 1905, Einstein gave the first rational explanation of this effect, thus laying down the foundation for modern television—and his answers were not rigged in advance, as has recently become the fashion.

Transistors and the resulting revolution in the electronics industry had their beginnings in the studies of crystal imperfec-



Variable Thrust Engine Powers Rocket Sled

Artist's conception of rocket sled for simulated flight testing of missile components shows layout of Aerojet-General Corp.'s newly-developed XLR-113-AJ-1 liquid rocket engine (AW Dec. 14, p. 35) which has variable thrust range from 59,000 to 150,000 lb.

tions and electric conduction in crystals less than 30 years ago. Almost the whole of our modern petroleum industry derives from basic studies of catalysis made by such men as Sabatier, Ipatieff, Haber and Taylor. The same derivation applies to bulk chemicals like ammonia, methyl alcohol, sulphuric acid and the industries that produce them.

The origins of the modern plastic industries are found in the basic studies of the two Meyers from Leipzig and Staudinger from Berlin in the 1930s, just as our present knowledge of the structure of polymers and the mechanisms of polymerization rests on the investigations of Bawn, Carothers, Flory, and Mark. Our miracle drugs and antibiotics go back to Fleming's creative work on penicillin, which was an almost accidental byproduct of his basic studies on bacteria. Much of the non-ferrous metals industry rests on the electrochemical investigations of Michael Faraday.

The plain fact is that almost any industrial process today, excepting only such basic operations as the smelting of common metals, can be traced to scientific experiments conducted within the last century by scientists who were little concerned with practical applications, and who seldom benefited personally from their achievements. And although we can have science without technology, as we did from the early beginnings of the experimental sciences in the 17th century until the close of the 18th and the beginning of the 19th centuries, when the Industrial Revolution began to make itself felt, we cannot have a growing technology without science. I need not argue that a thriving technology is essential for the healthy growth of our society, but in any case this is a thesis easy to prove.

Development Progress

Today we note that, although expenditures for basic research are increasing rapidly, they always remain but a small part of the total budgets for research and development. It is worth noting, too, that a study of the most recent industrial developments shows their scientific origins to be much more recent than those of developments undertaken some time ago. The use of atomic energy for ship propulsion is a case in point. Engines fueled by coal, modified and improved though they were, were used for a relatively short period in comparison with the much longer experience with sail. The transformation to oil was appreciably quicker still. But when the captain of the Nautilus first signaled that he was under way on atomic power, the Atomic Energy Commission itself was little more than a babe in arms on the oceans of the world.

Perhaps an even more striking example is that of stereo-specific diene polymerization, where but a few years passed between basic research and mass production of elastomers exceeding in performance the natural product.

It would seem that technological developments are catching up with the rate of new scientific discoveries: the scientific backlog, not yet exploited in full, is diminishing. It is this situation that is at times responsible for the failure of ambitious projects in the field of military hardware. Some of them rely not on basic new ideas to achieve advanced capabilities, but on elaboration of that which has already been developed. Complexity and high cost follow and the projects are justifiably terminated, because they threaten to become "Rube Goldbergs."

If we do not wish our technological progress to slow down, more effort must be put into the basic scientific research from which our technology derives. This point was sharpened, I believe, by a recent story in the New York Sunday Times, which I quote in part:

"In the United States, the Soviet Union, Britain and Western Europe, ambitious programs for the development of atomic energy are being delayed. Construction plans for commercial atomic powerplants are becoming indefinite hopes. Earlier optimistic predictions have been supplanted by vague forecasts and pessimistic complaints about the technical difficulties of harnessing the atom for peace. . . . On the international front there is pressure to reorient away from construction of atomic powerplants to research development."

To stress the differences between science and technology is not to imply value judgments, for each is equally necessary to our society, as I maintain. We need both, but we cannot hope to devise an adequate technology in a hurry without first having a sound foundation of basic science on which to erect it. Evidence of this cause-and-effect relationship greets us at every

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Delivery Capacity	Rated	12 scfm
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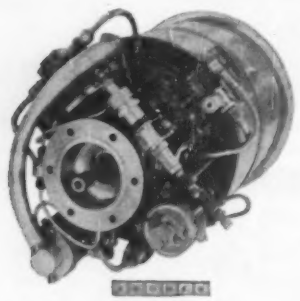
Driving Horsepower		13.5
Inlet Pressure		14.7 psia
Inlet Temperature		59°F
CONTROLS		
Cut-in—Cut-out Differential		300 psi
Cut-in Pressure		2800 psi
Cut-out Pressure		3100 psi
Pressure Relief		3300 psi
ENVIRONMENTAL		
Low Temperature		—65°F
High Temperature		+165°F



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turn, and although there are economic reasons for the situation I have just cited—and which we share with the USSR you will observe—I cannot but agree with its thesis.

The story leaves unanswered still another sober question: Where are we to find the full-blown scientific thought upon which to build the technology of tomorrow? It would seem that we tend to out-run, everywhere in the industrial world both here and overseas, the sources of basic reseach in science of which all new developments must depend.

Standard of Living

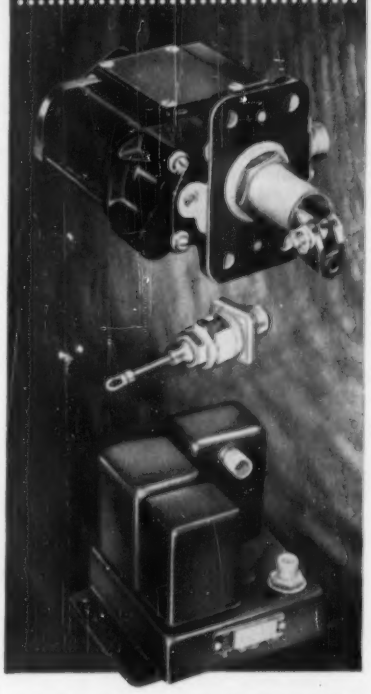
Our standard of living, of course, is a result of our technology, and this is the obvious conclusion that anybody draws. Our communications and transportation systems knit the nation together, fostering devotion to common ideals and objectives. The standard of living of which we so frequently boast is remarkably uniform across the nation. Technological gains result not only in better living for the individual, but in more efficient operations on the national scale. We are a nation that has great power but also lives well, enjoys good housing, good food, opportunities for recreation, and sufficient leisure to make the most of these creature comforts.

The homogeneity of our nation and the freedom from desperate struggle for existence—both are great technological triumphs—gives us, as a people, the opportunity to strive toward greater intellectual excellence, of which the pursuit of science is an integral and important part. But are we striving toward these high goals? We are not, as some thoughtful people believe. Let me quote from a recent speech by George F. Kennan, whose name, I am sure, is familiar to all of you:

"If you ask me—as a historian, let us say—whether a country in the state this country is in today: with no highly developed sense of national purpose, with the overwhelming accent of life on personal comfort and amusement, with a dearth of public services and a surfeit of privately sold gadgetry . . . with an educational system where quality has been extensively sacrificed to quantity and with insufficient social discipline even to keep its major industries functioning without grievious interruptions—if you ask me whether such a country has, over the long run, good chances of competing with a purposeful, serious and disciplined society such as that of the Soviet Union, I must say that the answer is 'no.'"

Thirty or forty years ago our already substantial and expanding technology leaned very heavily on imported scientific information. Countries like Germany and England were then the leaders in basic research; there were only isolated centers in the United States. The explosive growth of technological demands produced by World War II focused attention in this country, on the need for basic knowledge to speed technical progress. Science is still comparatively international in scope, and scientific information is freely exchanged across national boundaries. But we cannot rely any longer on German or English science because our own technology has outgrown the supply. The flow of scientific information

Electromechanical Components and Systems Capability



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from Western Europe can no longer meet our needs.

Could we then say with propriety: Let the people of the Soviet Union engage in science and when the need comes we can use their results in our own technology? Clearly, in a time of cold war and intense competition for world leadership, such a solution is not acceptable.

This issue was tested dramatically by our national reaction to the first USSR successes in space. The Soviets excel at present only in a narrow sector of technology, as I have said—the large sized rockets. But our own competitive instincts have been so aroused by their exploits in space that we feel an almost overwhelming urge to speed our technology in this field, so as to overtake or surpass them.

Public Reaction

If one separates civilian space science and technology from military missiles, which is entirely feasible, one wonders whether our insistence on superiority in space is of overriding importance. The unfortunate aspect is that space exploration has caught the public imagination to an extent that gives the Soviet achievements somewhat more importance than, perhaps, they rightfully deserve. The public reaction both here and abroad has been fostered assiduously—and not unnaturally—by the Soviet propaganda machine and, in a sense, by some of our own space enthusiasts.

Viewed in the context of over-all competition for intellectual leadership in science and technology, however—and discounting the emotional and political factors involved—our concern about space exploits might be questioned on grounds of reason and logic. It is characteristic of dictatorships that they are able to concentrate their national efforts more effectively than the democracies on limited objectives and thus gain a temporary superiority. Moreover, in view of the general strength of the USSR, it would be totally unrealistic of us to expect that at any given time we should be their superiors at every point on a broad scientific and technological front. We must accept as a fact of life that in certain areas, which will vary from time to time, the Soviets will be ahead of us temporarily.

If the points of their superiority were to expand into broad fronts, however, we should soon cease to be regarded as world leaders. The result might be that the free world of today would contract and shrink through defections to the side of communism as the leadership of the future. The obvious conclusion, therefore, is that not only do we need basic research for the advancement of our American science and technology, but that American scientists must be international leaders.

Because science has played a prominent role in America's intellectual growth only within the past few decades, it has not had the conscious, almost exalted public recognition that it has long enjoyed in Europe.

There, scholarly activity has long been recognized and appreciated as an admirable occupation.

Here even the concept of science is unclear in the minds of the public, al-

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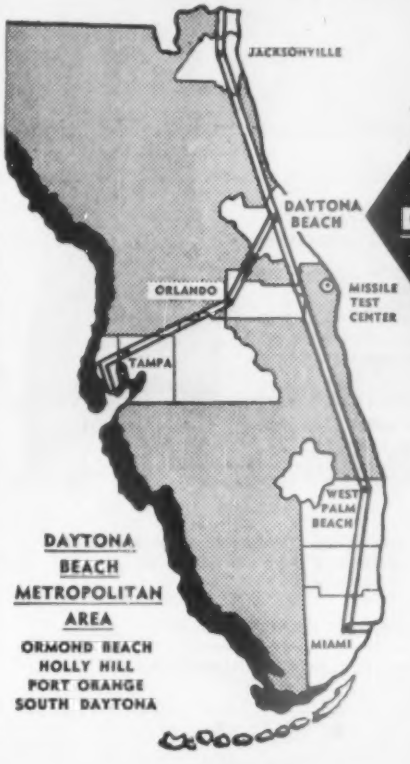

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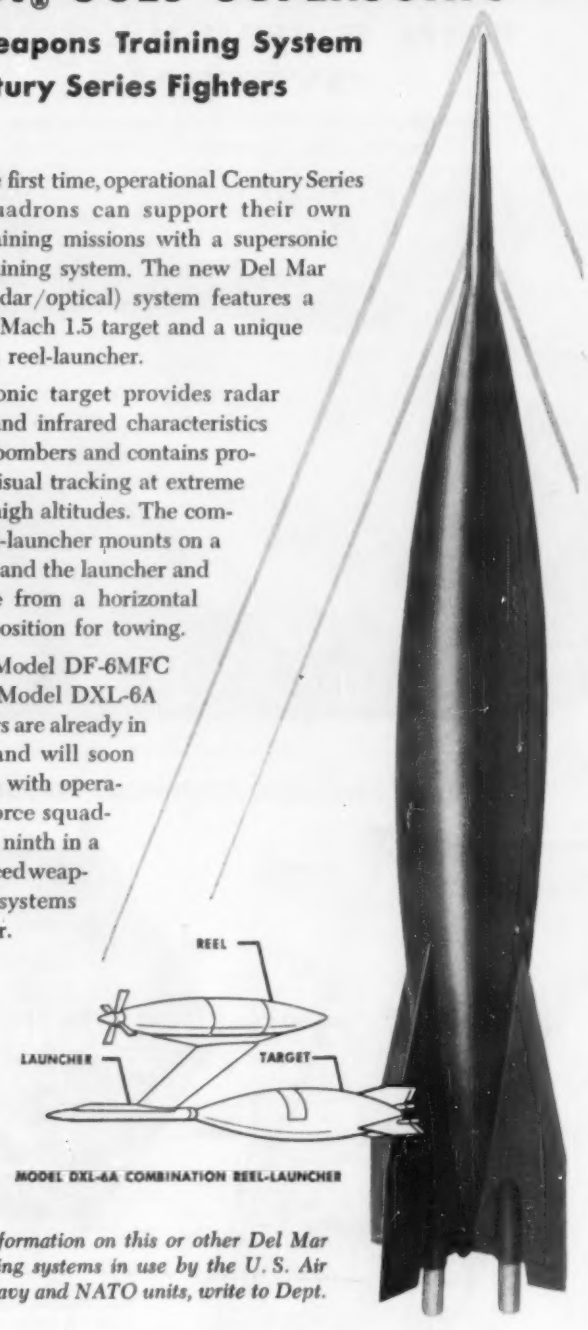

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though, since the advent of the Sputnik it became rather fashionable. The advertiser and his agency, for example, seem to believe that anything labeled "science" carries weight and conviction, even though their sales message may have no basis in science or even in common sense.

When a vendor on a screen, with a test tube in his hand, mouths about science, I feel only annoyed, but possibly—when dinned into the ears of millions of juveniles—the message has another effect altogether. There is some incidental evidence that science—meaning, frequently, technology—is now likely to be the subject most discussed by our youth.

What does this mean, if true? It could mean that intellectual excellence has acquired new prestige in the eyes of the young. Since Sputnik I, there have been numerous conversions. Many of us have been made uncomfortably aware that we could not afford to be complacent regarding our science and technology. The resulting reappraisals of the method and objectives of our education have been valuable. In this area we are moving forward and are moving effectively, but it is too early to be satisfied with the results. We still face a crucial challenge on the intellectual front.

We are sorely in need of a greater devotion to learning, a greater pride in intellectual achievement, a greater appreciation of excellence in general, throughout our national life. And we must keep in mind that in our society science has a central role to play in intellectual creation and in the generation of basic ideas. When new concepts and ideas cease to flow, the very wellsprings of technology and engineering will run dry.

Government Measures

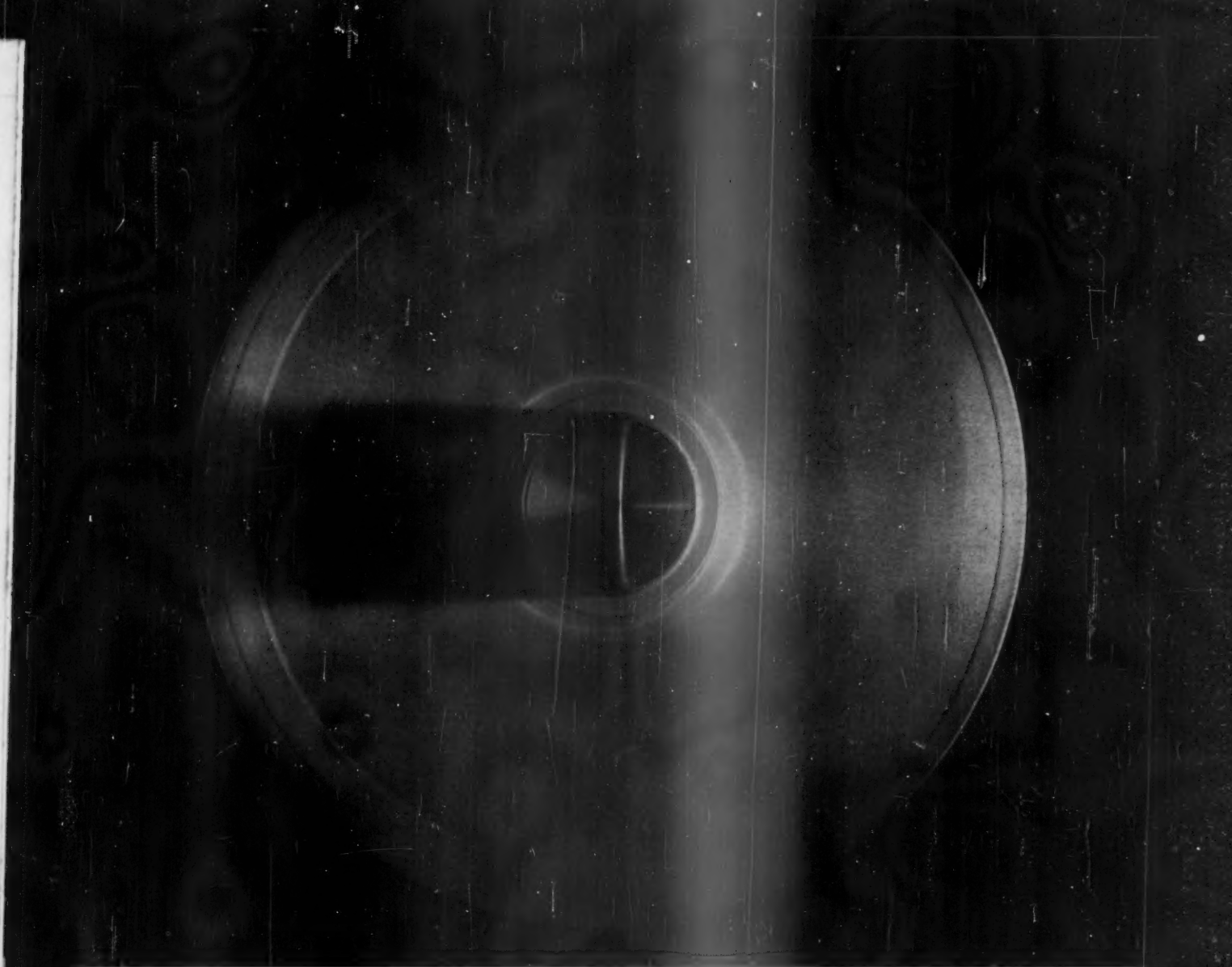
I should like to tell you briefly now about some of the measures your government has taken in order to bring these problems into focus, and thus to help bring about corrective action.

In two speeches during November, 1957, President Eisenhower emphasized the need for strengthening science education and bringing our over-all scientific and technological effort to peak performance levels.

In the first of these speeches, in which he called for an all-out effort to mobilize the best resources of science and scientists in support of the national security and welfare, the President announced the creation of the office which it is now my privilege to hold. He also reconstituted on the White House level the Science Advisory Committee. Later, in his 1958 State-of-the-Union message, President Eisenhower stated: "In both education and research, redoubled exertions will be necessary on the part of all Americans if we are to rise to the demands of our times."

The office I hold did not exist before November, 1957. Nor had there been, except for the wartime National Defense Research Committee, a science advisory committee directly responsible to the President. The NDRC had large operating responsibilities. The present committee and the special assistant do not. Our function is advisory.

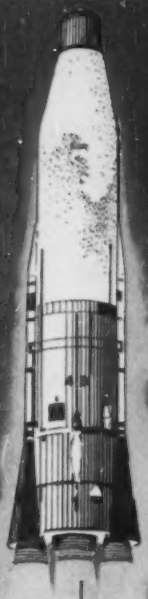
The President's Science Advisory Committee is responsible primarily for making



A data recorder is for recording data. Every minute its reels are stopped for warm-up, calibration or maintenance is a minute that it is not really a data recorder. It is instead a delay, a headache, a problem. By cutting every possible source of down-time to a minimum, the Ampex FR-600 literally works twice as many hours as the average recorder in every working day. Switch it on in the morning, for example, and the all-solid-state electronic circuitry is warmed up, ready to calibrate *in less than 10 minutes*. FM adjustments are non-interacting. You make each one only once. In half an hour you can have all 14 tracks ready to use. Then you forget calibrating for the rest of the day because drift is less than 1% in 24 hours. Dozens of other features save time, too. Magnetic heads retract, for instance, never touch the tape during fast forward or rewind. Oxide build-up and head-cleaning time are sharply cut. These studied simplifications make the FR-600 the most time-saving, hard-working data recorder you can use. The full FR-600 story is well worth hearing. AMPEX DATA PRODUCTS CO., 934 Charter St., Redwood City, Calif.

This recorder works twice as many hours every working day

MOST OF THE ANSWERS MUST BE KNOWN IN ADVANCE



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scientific advice and analysis available wherever they are needed in the formulation of national policy. It also concerns itself with the effect of national policies on the nation's scientific and engineering activities. The committee provides answers to questions raised by the President, undertakes assignments for him of an advisory kind, attempts to mobilize the best scientific advice of the country in behalf of the federal government, and recommends measures through which United States' science and technology can be advanced.

The committee endeavors to ensure that science and technology contribute their maximum to the welfare of the United States by seeking ways:

- **To enhance the excellence** of U. S. science, both basic and applied, and to add to our effort, relatively, in basic research.
- **To extend the recognition** of science as a creative activity that augments man's dignity and understanding and affords him intellectual adventure of the highest order.
- **To recognize that outstanding** accomplishments in science appeal deeply to the hopes and aspirations of men everywhere, and contribute to the prestige and good will of nations.
- **To demonstrate** that the democratic environment of the free world is the best environment for achievement in science.
- **To improve the ways** in which our government uses and supports science and technology.
- **To apply technology** more effectively to improve our national security, to strengthen our economy, to enhance the health and welfare of our citizens and other peoples.
- **To promote international** understanding and good will.

Significant Achievement

These are broad and ambitious objectives. Even small progress in each area would be a significant achievement.

The organization that works toward these goals comprises the 18-man committee proper, numerous panels involving members as well as consultants, the special assistant, and his small full-time staff of technical aides. The committee's members are representative of those fields of science and technology especially important to the government. The membership rotates, most of the new appointments being on a four-year basis. This practice brings to the committee fresh points of view and representation from different fields of science and technology.

To discharge its responsibilities, the committee has established panels, some on an ad hoc, others on a continuing basis. First Dr. Killian, and then I, were elected to the chairmanship of the committee, which knits the whole organization together. My personal full-time staff is also the staff of the committee and its panels.

The panel structure has consistently been a distinctive feature of the committee's work. It has made possible intensive studies on problems that could not have been undertaken by the committee because of its limited membership. At the present time, over 100 scientists and engineers are associated with the committee and my office in part-time capacities, thus providing a wide range of expert advice. Committee and panel members are selected not only because of their expert knowledge and

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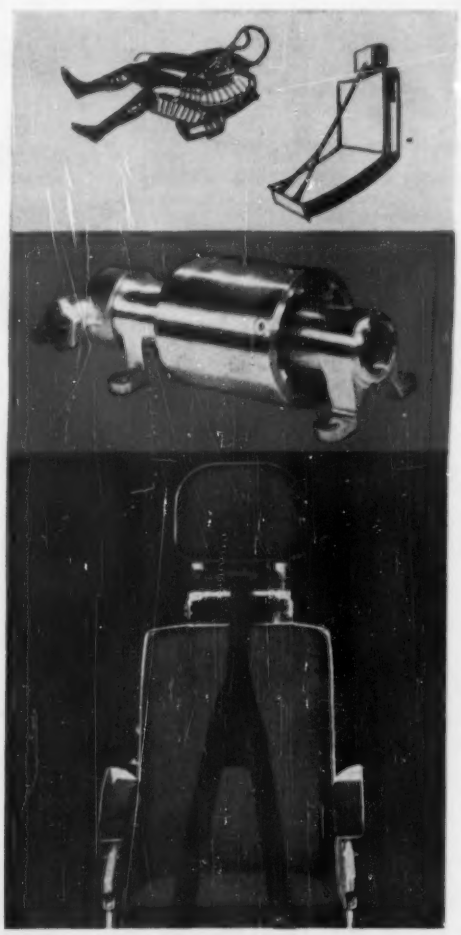

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achievement, but also because they possess something that I may perhaps dare to call wisdom in a broader sense.

Partnership in this organization means work and, therefore, some sacrifice of personal careers. It is willingly undertaken in the spirit of national service. You will appreciate the magnitude of personal involvement when I mention that more than 500 man-days of work were needed recently for the study of certain problems in the classified area and the preparation of one short summary report.

A major concern of the committee is how to bring the young generation of scientists and engineers into our panels and other types of advisory services to the government. We need to explore every way of making their services, skills, and fresh ideas available without handicapping their professional developments, or curtailing their contributions to science.

The special assistant, as a member of the President's staff, is invited to attend meetings of the National Security Council and of the Cabinet, and—when appropriate—to present the views and findings of the Science Advisory Committee. He is also a member of, or attends the meetings of, special Cabinet-level interdepartmental committees, such as the Radiation Council and Space Council. He is the chairman of the new Federal Council on Science and Technology, consisting of representatives, at the policy-making level, of 10 departments and agencies.

Some of the panels of the Science Advisory Committee deal with unclassified fields of interest to the federal government, and a few of their activities have led to reports and statements which were published under the imprint of the White House. I list here the titles to indicate the broad scope of these activities:

- **Introduction to Outer Space.**
- **Scientific Information.**
- **Strengthening American Science.**
- **The Argus Experiment.**
- **High Energy Accelerator Physics.**
- **Education for the Age of Science.**

Other panels' activities result in detailed recommendations to various agencies of the executive branch of the government, which are not suitable for public dissemination, such as the work of several panels dealing with classified matters pertaining to the national security.

The creation of the office of the special assistant and of the Science Advisory Committee is, however, but a small part of the actions which the President and Congress have taken recently to strengthen American science and technology and to make the government process more responsive to a world of rapidly changing technology.

These actions include:

- **Expansion of the National** Science Foundation program and a three-fold increase in its appropriations for support of basic research and education in the sciences.
- **Enactment of the Department** of Defense Reorganization Act, reflecting the impact of modern weapons technology and systems engineering on the military establishment.
- **Establishment of the Office** of the Director of Research and Engineering and the Advanced Research Projects Agency in the Office of the Secretary of Defense.
- **Assignment of engineers** and scientists at policy-making levels in the offices of the secretaries of the three services.
- **Establishment of the National** Aeronautics and Space Administration to provide a civilian space-science and exploration agency.
- **Reactivation of the Office** of Science Advisor to the Secretary of State, and the appointment once again of Science Attaches to overseas posts.
- **Establishment of the Federal** Council for Science and Technology as a means of bringing together for common planning policy-level representatives of agencies having major scientific programs.
- **Enactment of the National** Defense Education Act, designed to aid education generally, with specific provision for strengthening science education.

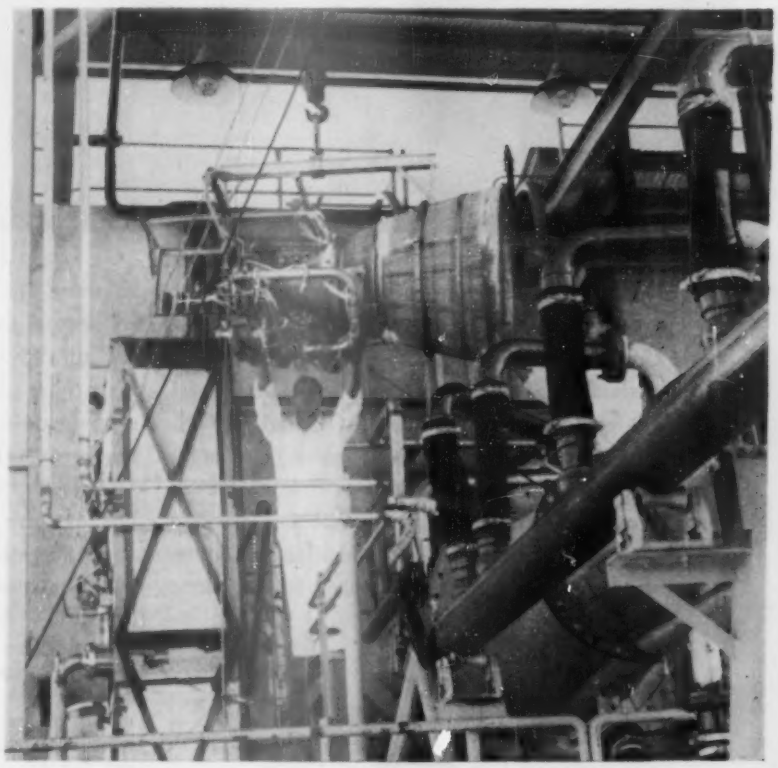
In the Congress, the House of Representatives established a standing committee on Science and Astronautics. The Senate, also, has created a new standing committee on astronautics and space science. A number of important actions have been taken by the Congress, and by the executive branch, to improve the status of scientific personnel in the service of the government.

In addition to these national efforts, there have been important advances in international cooperation—an example is the second Atoms for Peace Conference in Geneva. It was at this conference that the United States and the United Kingdom joined in announcing the declassification of research in the field of controlled fusion.

Our aims, as manifested in these and other measures, can be summed up in a few simple words: Our national objective need not and should not be solely the creation of an elite of intellectuals. It must include raising and improving the intellectual tone of our whole society, so that scholarly achievements in science, as in other fields, will attract the ablest young minds.

May such achievements stimulate new joys and satisfactions, not only as the young face their high school and college years, but throughout life. I would wish for them, as they enter man or womanhood, something akin to what Winston Churchill meant when he said that God had created two kinds of good and useful human beings: those who work only to be able to play and the happy ones for whom work is play. It is, perhaps, that through experiencing this kind of happiness we shall be able, as a nation, to disprove the dire predictions of George Kennan which I mentioned earlier.

We are a young nation, still filled with pioneer spirit, even though it might be temporarily obscured by easy living. This is only a passing phase, and I have faith that we shall head into the new frontier—the frontier of intellectual achievement. A great mind, Albert Einstein, best expressed what I am trying to say: "It is a great gift if one is permitted to work in science for his whole life."



Technicians Test Centaur Hydrogen Engine

Hydrogen-fueled Pratt & Whitney XLR 115-P-1 engine for the Convair Centaur space vehicle upper stage (AW Dec. 7, p. 30) is readied for test run. Steam ejector system at right evacuates diffuser behind the engine nozzle, creating vacuum necessary to simulate the space conditions under which the engine first fires.

Ever try threading five needles at once?

Cubic has, electronically speaking. And far greater precision is required of the five-target Cubic MOPTAR which will be used by the Federal Aviation Agency to evaluate experimental air-traffic-control systems. MOPTAR (Multi-Object Phase Tracking and Ranging), an *omni-directional* system requiring *no moving antennas*, provides startlingly accurate real-time position data. MOPTAR can be expanded to track *hundreds of aircraft* simultaneously with this same accuracy. The FAA installation will monitor other systems in tests at the new National Aviation Facilities Experimental Center near Atlantic City. It's a new use for Cubic's Space Age tracking systems developed under the forward-looking sponsorship of the United States Air Force. Now MOPTAR finds a non-military application in helping solve the problems of air navigation, an application that will lead to greater safety in the traffic lanes of the sky.

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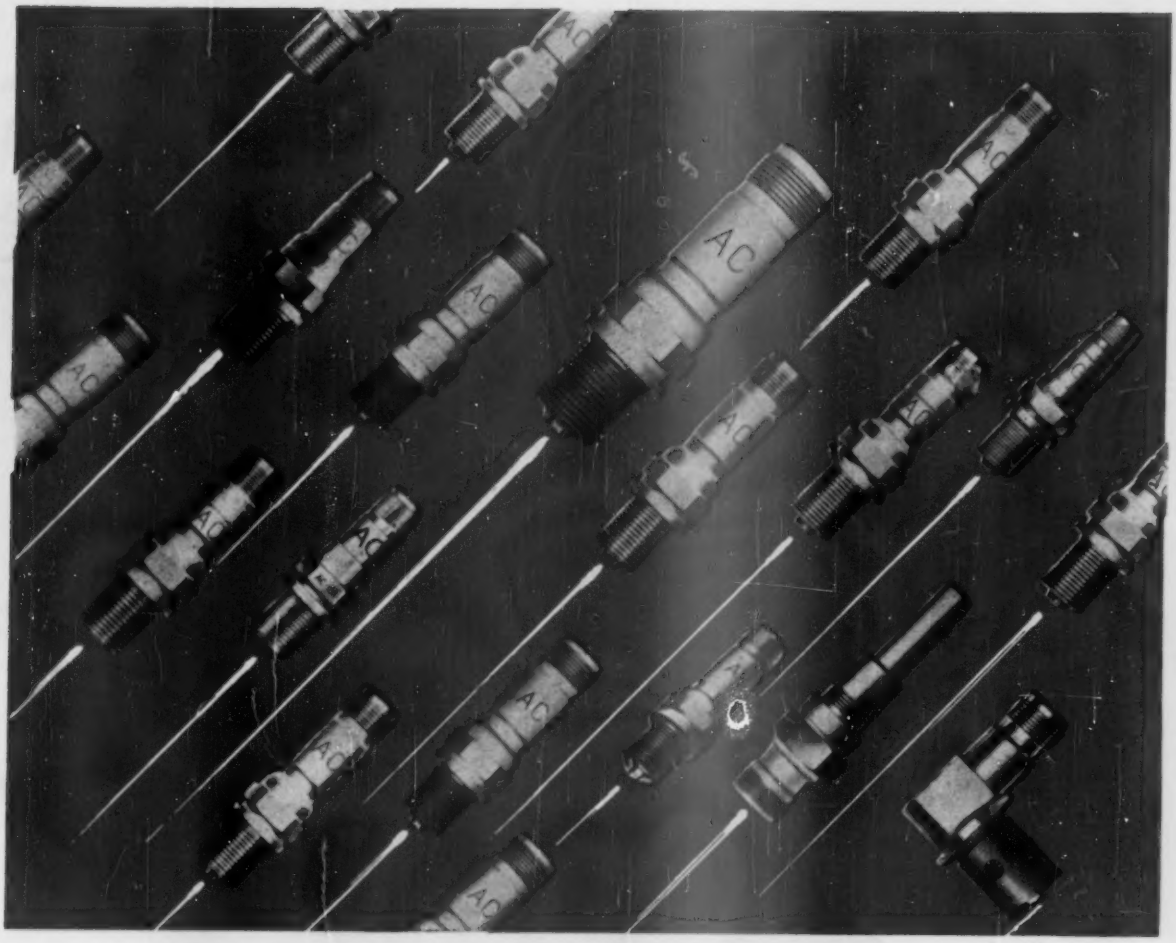

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VIDEO-SONICS, new technique developed by Hughes Aircraft, gives each operator on an avionics assembly line step-by-step instructions for every operation using magnetic tape playing through individual operator's headset and a series of color slides which show how chassis should look after each operation. Slide is projected on small screen in console that resembles portable television set (arrows).

Video-sonics Cuts Production Defects

By Philip J. Klass

Culver City, Calif.—Video-sonics, a combination of a new device and technique, has enabled Hughes Aircraft Co. to slash the defect rate in its avionics manufacturing operations by as much as 100:1 while also improving product uniformity, increasing output and reducing factory personnel training time.

The impact of Video-sonics has been "staggering," according to one company official.

Video-sonics also holds promise for military use to train operating and maintenance personnel and for use at overhaul depots to achieve factory level capability, Hughes believes.

Mainly Technique

The Hughes-developed Video-sonics is "10% hardware and 90% technique," according to R. B. Parkhurst, vice president and general manager of Hughes Products Group. The equipment itself is relatively uncomplicated, consisting of an automatic 35 mm. slide projector and a magnetic tape reproducer built into a box containing a small projection screen. The combination resembles a portable television set. A lightweight headset (earphones), a magazine of 35 mm. color transparencies and a prerecorded magnetic tape, also in a magazine, complete the hardware.

The equipment is installed at individual work stations on an assembly line. The magnetic tape and headset provide each operator with a detailed set of aural instructions for assembling and wiring the chassis under construction while the projector displays a color photo which shows how the operation should be performed and how the chassis should look at each stage in the operation.

The use of visual display plus aural instructions distinguishes the Hughes approach from those employed by Westinghouse and Western Electric which use only aural instructions.

The taped instructions and slides for each operation are synchronized. The tape delivers an instruction, then allows the operator a suitable interval to perform the task. Tape then sounds a beep note to indicate to the operator that another instruction is about to begin, which automatically causes the projector to change to the next slide.

Parkhurst emphasizes that the individual operator is in command of the machine, not vice versa. If the operator is not ready for the next instruction, she need only push a foot pedal or button to delay it. If the operator finishes an operation ahead of the allotted time, she can initiate the start of the next instruction.

Because each operator has her own Video-sonics machine, she can set her own work pace. Background music is piped into the machine's sound system, but can be turned off if the operator so desires. When taped instruction is about to start, the background music volume is reduced slightly, returning to normal after the instruction is completed.

For each operation, Hughes usually produces three different types of tapes. The first, used when a new chassis or a new operator comes on the assembly line, gives very detailed instructions with many cautions or warnings.

When an operator feels sufficiently experienced, she can request the abbreviated tape instructions. A typical abbreviated instruction might be as follows: "Obtain capacitor P-1, install as shown. Be sure to maintain clearance." If and when the operator so desires, she can request the super-short version, sometimes referred to as the "Bikini." The previous operation on this tape would be as follows: "P-1, as shown."

Use Is Optional

Hughes does not insist that its operators use the Video-sonics machine. They can use the aural instructions, the visual display, both, or neither. However, during an AVIATION WEEK visit to Hughes El Segundo airborne fire control manufacturing plant, every operator in view was using the Video-sonics headsets and making frequent reference to the visual display.

The idea of combining aural instructions on tape and a visual display is credited to Jack Barry, at the Hughes

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El Segundo plant where it was first tried. The man who heads the Video-sonics program at Hughes, D. E. Stewart, frankly admits that he was one of the "most doubtful Thomases" when the idea was first suggested in March, 1958, for application at the Tucson plant where he then worked and where Hughes produces Falcon missiles. Stewart adds that he was not alone in this view among Tucson personnel.

Prior to a trial of Video-sonics on a Tucson line, Hughes had been experiencing an average of 6 to 13 defects per chassis—a defect being a cold solder joint, a solder splash, a loose or reversed component or insufficient clearance between components.

Within five months after Video-sonics was introduced, the defect rate had dropped to an average of only 1½ per chassis. Within 10 months, the defect rate was only 0.06 per chassis—a reduction of 99%.

With so drastic a reduction in defects, Hughes was able to eliminate a special group that had previously been used to re-work rejects. Instead the chassis could be returned to the original worker without disrupting production schedules, Stewart says.

The results were so spectacular that Tucson decided to install 60 of the machines as soon as they could be built.

Another result: Stewart became one of Video-sonics' strongest proponents, second only to Parkhurst.

Hughes now has more than 1,000 of the machines installed at its Tucson and El Segundo manufacturing facilities and is starting to install them at its Fullerton (ground-avionics) plant.

Before the advent of Video-sonics, Hughes found that its most experienced operators were able to achieve about 60% realization of production planners' work standards, with less experienced operators falling below this figure. After Video-sonics was introduced, practically every operator on the line could achieve 90% to 100% of the work standard and do so consistently throughout the day, according to Parkhurst.

On one assembly line making a critical intermediate frequency amplifier, it previously required about four months for an operator to get up to the line's average realization of about 53% of the work standard. After Video-sonics was installed, Hughes transferred a new operator from the wire harness line into the IF amplifier line. By the end of the first day she had achieved a rate of 80% of the work standard.

With Video-sonics, the period required to train an operator on a new chassis can be slashed from weeks to less than a day, in most cases, Parkhurst says. For example, an experienced operator can be put on a new job and

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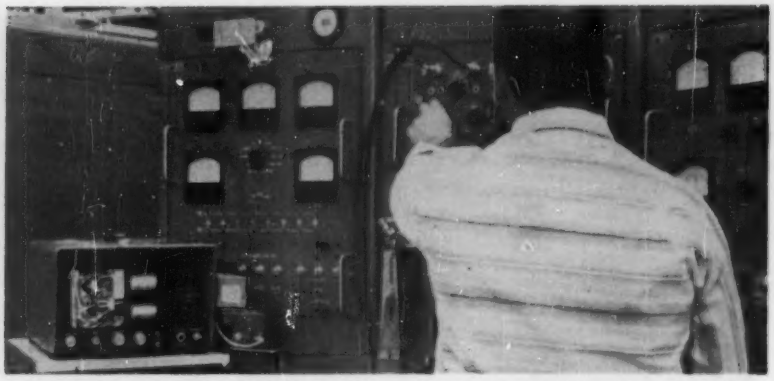

DEFECT RATE in avionic assemblies has been slashed by as much as 99% using new Video-sonics technique and machines (left). Background music also is piped into the operator's headset. Operator can adjust volume, turn off tape or projector at will. Hughes also is using Video-sonics for machine tool operations and in test (right) where projector shows connection points and desired wave shape.

by the sixth chassis she normally will be up to nearly 100% of the work standard.

Video-sonics assures that every operator working on a particular chassis follows the same assembly procedures and works to the same standards, eliminating the variability that formerly resulted from possible differences between individual line supervisors. With the new technique, the supervisor is largely relieved of his duties as an instructor and is able to concentrate his efforts on managing people.

Engineering changes can be introduced in a matter of hours, with operators quickly resuming their former work standards. Hughes is set up to produce new taped instructions and new color transparencies within four hours after the change is established, according to Stewart. These are introduced on the line by merely substituting the new tape magazine for the old and by replacing one or more of the 35 mm. slides in the projector magazine.

Other Applications

Hughes has applied Video-sonics to a number of other functions in addition to assembly line operations. For example, the technique is being used for test and inspection. Where tests require the use of a cathode ray oscilloscope and observation of wave shape, the color slide can show the precise waveforms which should be obtained. In one systems test operation, Hughes found that Video-sonics cut the time required from five hours to only 17 min., a 95% reduction.

Hughes finds that Video-sonics also can be applied to machine tool operations, with comparable gains in product quality and output.

Company officials are equally excited over the potential military applications for Video-sonics. Hughes has used the technique in training pilots to operate its fire control systems.

With Video-sonics it is possible to duplicate factory procedures and techniques at military overhaul facilities by supplying them with the same slides and magnetic tapes used in the Hughes factory. Air Force currently is evaluating Video-sonics at its Middletown Air Materiel Area and at Holloman AFB.

Video-sonics also makes it possible to overcome language difficulties, Stewart points out. The magnetic tape can be prepared in any desired language, assuring an accurate translation of factory or maintenance procedures for NATO countries using U.S. equipment.

In a recent demonstration for visiting Swedish air force personnel, the regular magazine of 35 mm. slides was used to explain the operation of a fire control system, but the accompanying aural instructions had been thoughtfully taped in Swedish, which understandably made a hit with the visitors.

Video-sonics also provides a convenient means for transferring production know-how from one plant to another within a company or to a second-source manufacturer. Video-sonics is particularly well suited for military production where the runs may be short but repeated at intervals. The tape and slides can be stored, then reused to re-train personnel when an additional production run is ordered.

Behind the Scenes

Hughes has learned that a great deal of thought and effort must go into the preparation of the slides and taped instruction if Video-sonics is to prove effective. Without such effort, the machines themselves contribute little.

For example, Hughes found by experimentation that for female operators the voice on the magnetic tape should be that of a man. Hughes therefore uses a professional male announcer with a very masculine voice.

If the operators are to accept the Video-sonics voice and photos as gospel, and follow them to the letter, both the aural and visual instructions must be flawless. The slightest error may be duplicated by every operator on the line until it is detected.

A vast amount of effort goes into the planning and prepara ion of the script for the taped message. When a new chassis is ready for production, the design engineer, manufacturing engineer, planner and a member of the Hughes Video-sonics group join forces. They assemble the chassis, recording every step, every precaution that must be observed, making photographs as they go. Photos are taken at the same angle from which the work will be viewed by the operator on the line.

The manufacturing standards man, after careful study, comes up with an estimate of the time required to assemble the chassis.

Trial Tape

A trial tape is then prepared, together with 35 mm. slides for each operation. An experienced operator is then brought in to assemble the new chassis working entirely from the Video-sonics instructions. Any questions, omissions or errors disclosed by this operator are then introduced into the program.

When the experienced operator has been able to assemble six chassis in the time allotted for the operation by the standards man, the program is considered ready for the production line.

Hughes has learned that it is vitally important to talk with each operator before Video-sonics is first introduced on a line to explain its function and to emphasize that she is the machine's master, not its slave. Similar orientation is required for supervisors to explain their changing role.

Hughes officials have carefully weighed the possibility of selling Video-sonics to outside companies. At least for the present, Hughes has decided against it. One reason is that Hughes

Where shall we put <u>your</u> payload? We can put your 50-pound package 1000 miles up or your 1000-pound payload 57 miles up. The systems hardware we use—most of it our own—has a long record of success and a refreshing respect for small budgets. Call on us for the whole job or any part. Just find your need on the chart, and we'll do the rest. **Cooper Development Corporation,** 2626 South Peck Road, Monrovia, California.

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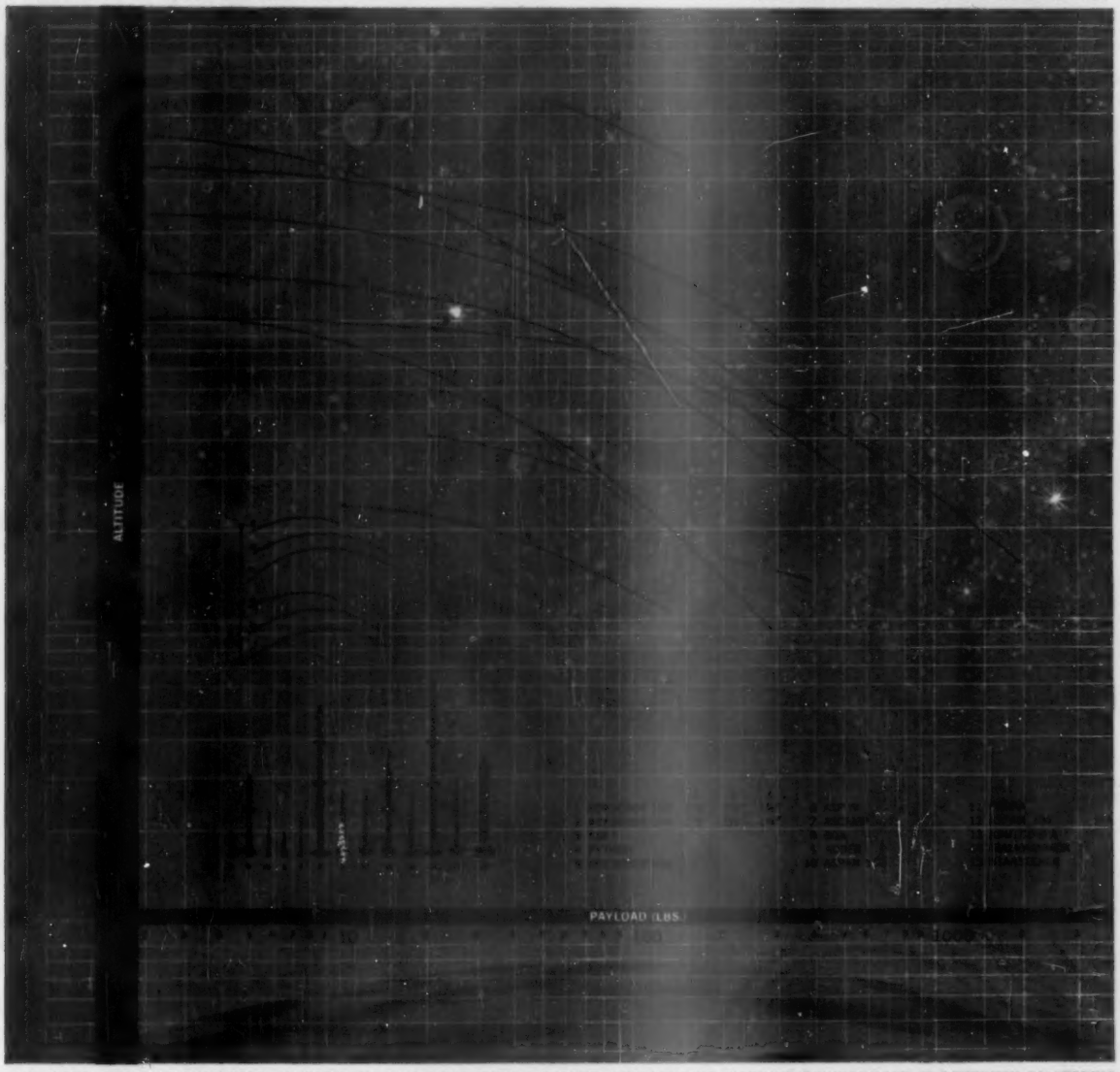

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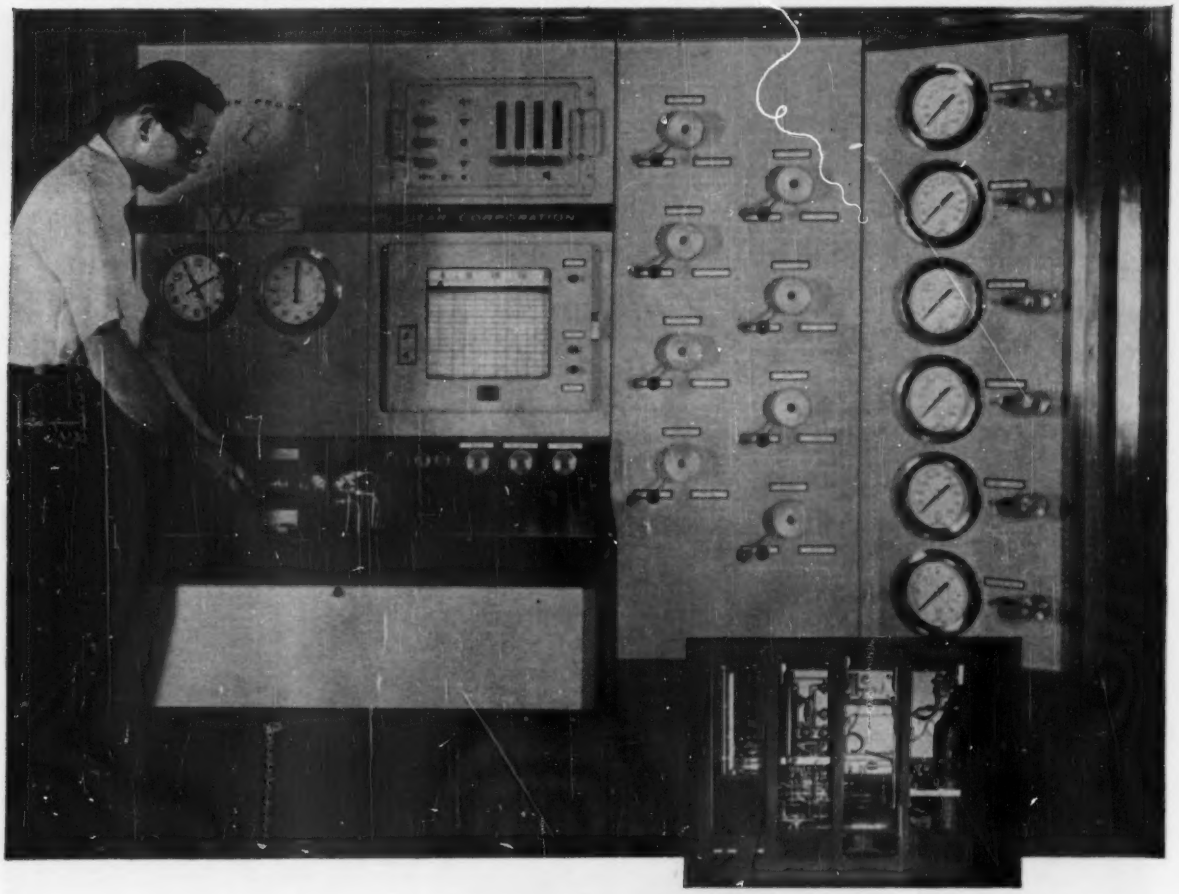
Three system test stand console designed by Western Gear for field servicing of Convair F-106 Vari-Duct Drive unit. Fourteen individual performance tests guarantee reliability. High pressure hydraulic test at 4500 psi, low pressure at 300 psi, pneumatic emergency test at 2500 psi. Features built-in include safety precautions to prevent unit damage during test and calibration. Performs static, operational, load, stall and running tests, includes counter and recorder. Stainless steel piping throughout.



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Bureau of Standards Unit Prefixes

Washington—The National Bureau of Standards has adopted new prefixes for multiples and sub-multiples of units which were recommended by the International Committee on Weights and Measures at its 1958 fall meeting in Paris. The Committee expanded the familiar list of eight numerical prefixes to a total of 12, with corresponding symbols, as shown in table below. Examples of how new prefixes will be used: a capacitor with a capacitance formerly expressed as 5 micro-microfarads (5×10^{-12}) will be 5 picofarads, abbreviated 5 pf. Asterisks indicate newly added prefixes.

Multiples and Sub-Multiples	Prefixes	Symbols
$1\,000\,000\,000\,000 = 10^{12}$	tera*	T
$1\,000\,000\,000 = 10^{9}$	giga*	G
$1\,000\,000 = 10^{6}$	mega	M
$1\,000 = 10^{3}$	kilo	k
$100 = 10^{2}$	hecto	h
$10 = 10$	deka	dk
$0.1 = 10^{-1}$	deci	d
$0.01 = 10^{-2}$	centi	c
$0.001 = 10^{-3}$	milli	m
$0.000\,001 = 10^{-6}$	micro	μ
$0.000\,000\,001 = 10^{-9}$	nano*	n
$0.000\,000\,000\,001 = 10^{-12}$	pico*	p

would be selling know-how acquired over several years to other avionics manufacturers, strengthening their ability to compete with Hughes. Furthermore, companies already manufacturing slide projectors and/or tape recorders for the price-conscious consumer market probably could produce the hardware for less.

However, Hughes has no compunction about revealing its Video-sonics know-how to the military services and does expect to apply the technique to a number of defense situations.

NEW AVIONIC PRODUCTS

Microwave Amplifiers

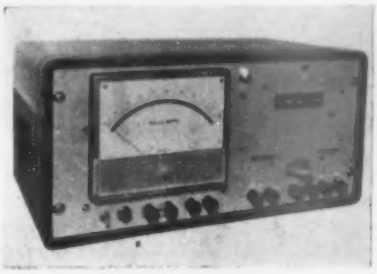
• **Amplifier, Model 549,** uses traveling wave tube for broad band amplification with 30 db. gain and 10 mw. output from 10.5 to 16 mc. Front panel connectors available for AM and phase modulation. Weighing 33 lb., unit can be bench or rack mounted and, firm says, employs simple, rugged design. Alfred Electronics, 897 Commercial St., Palo Alto, Calif.

• **Power amplifiers,** Models 216A and 217A, turn out 10 and 1 kw., respectively, both use four cavity, water-cooled klystrons, and can be tuned from 1,700 to 2,400 mc. As broadband amplifiers, they provide minimum gain of 40 db. Models 216A and 217A have maximum bandwidths of 18 and 15 mc., respectively, measured at ½ power points. Model 217A is self-contained in single 84 in. high, 44½ in. wide and 41 in. deep cabinet. Sierra Electronic Corp., 3885 Bohannon Drive, Menlo Park, Calif.

Test Equipment

• **Telemetry test set,** FM/FM, in compact, mobile package, can be used in checkout of magnetic data recording and oscillographic data recording systems, subcarrier generators and reference oscillators among others. Test set covers 18 rdb. channels; subcarrier generators for all 18 rdb. frequencies can be modulated plus or minus 7½% while five highest frequencies can be modulated plus or minus 15%; and all subcarrier generator outputs available individually or as composite. Set operates on 110 v., 60 cps. Dynatronics, Inc., Box 2566, Orlando, Fla.

• **Wattmeter,** Model 1483, designed for measurements at sustained accuracy



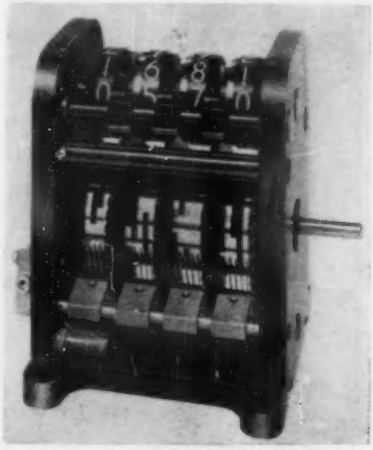
and resolution down to 0.01% of rated input, according to firm. Meter ranges are 250/500/1,000 watts; input currents are 5 amp. normal and 10 amp. max.; input voltages are 50/100/200 v. normal and 75/150/300 v. max. Frequency range is 40 to 1,000 cps. Meter's dimensions are 20 x 14 x 10 in. and weight is 27 lb. Daystrom, Inc., 614 Frelinghuysen Ave., Newark 12, N. J.

Components & Devices

• **Disk thermistor,** Number 34D4, has resistance of 13,096 ohms, at 0C ranging down to 270 ohms at 100C, with

5% tolerance. Unit is suited for temperature compensation or temperature measurement, according to Victory Engineering Corp., Box 373, Union, N. J.

• **Power converter,** Model 12AS115, transistorized, operates from 12 vdc. and converts to 115v. 60 cps. a.c. and permits use of electric shavers, dictating equipment, tape recorders and radios in cockpit, firm says. Converter weighs 8 lb. 6 oz., measures 4⅜ in. wide, 6¼ in. long and 3¼ in. high, and has efficiency of 65 to 72% at ¼ to full load. Webster Electric Co., Racine, Wis.



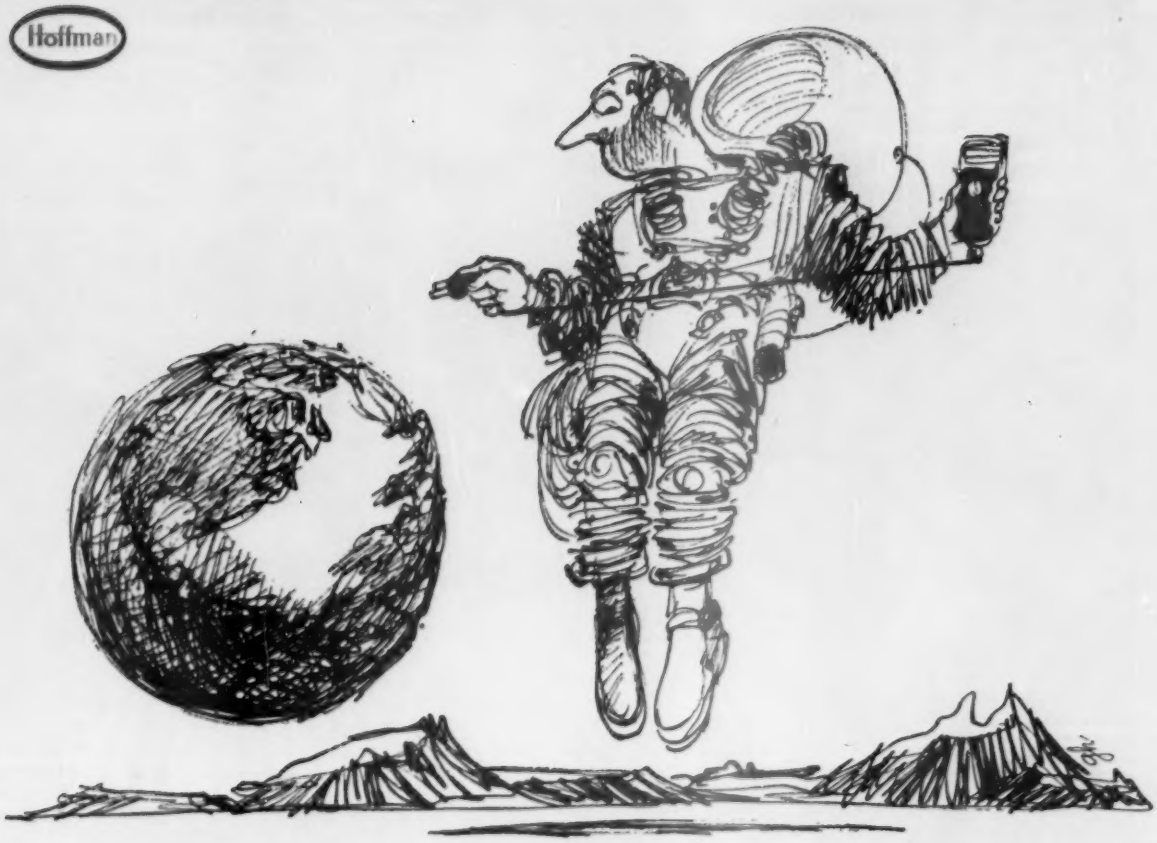
• **Analog-to-digital converter,** Model 423341, has following typical characteristics: 2 in.-oz. input driving torque; 250 max. rpm. input shaft rotation; −80 to 350F operating range; 5 to 50 cps. at ±10g vibration range; 0.187 in. height; 20 ma. each, 20 vdc. contact and brush capacity; up to 4 figure digitalizing capacity and 1 bit per 10,000 bits resolution. Kearfott Co., Inc., Little Falls, N. J.

USAF Pilots Receive Awards for Record Flights

Air Force pilots who established three world aviation records at Edwards AFB, Calif., were awarded trophies for their achievements (AW Dec. 21, p. 24). In the photo at left above, Maj. Joseph Rogers receives the Thompson Trophy for setting a world speed record of 1,525.9 mph. in a Convair F-106, exceeding a 1,484 mph. record claimed in October by the Soviet Union for a single-turbojet Sukhoi delta designated the E66. Lt. Gen. Mark E. Bradley, USAF deputy chief of staff for materiel, is at left; G. R. Moore, vice president of Thompson Ramo Wooldridge Corp. who presented the trophy, is at right. In the photo at right above, Brig. Gen. Joseph H. Moore receives a special Bendix award for flying an operational Republic F-105B from the 334th Tactical Fighter Squadron at Seymour-Johnson AFB, N. C., over a circular 100-km. course in 183 sec. The course was laid out in a circle with a 9.9-mi. diameter. Lt. Gen. Bradley is at left; Roy H. Isaacs, vice president-government relations, Bendix Aviation Corp., who presented the award, is at right.

Capt. J. B. Jordan (second from right) receives the General Electric Trophy for setting a world altitude record of 103,395 ft. in a Lockheed F-104C interceptor. Capt. Jordan set a 30,000-meter time-to-climb record during the same altitude run, attaining 98,424 ft. altitude 15 min. 4.92 sec. after the flight began. The altitude record exceeded by 4,835 ft. the 98,560 ft. record set by the U. S. Navy a week earlier with a McDonnell F4H. Other members of the group above are, left to right, Brig. Gen. D. E. Newton, USAF; J. V. Guthrie, Lockheed Aircraft Corp.; Lt. Gen. Bradley, and George Metcalf, General Electric vice president who presented the trophy.

Hoffman



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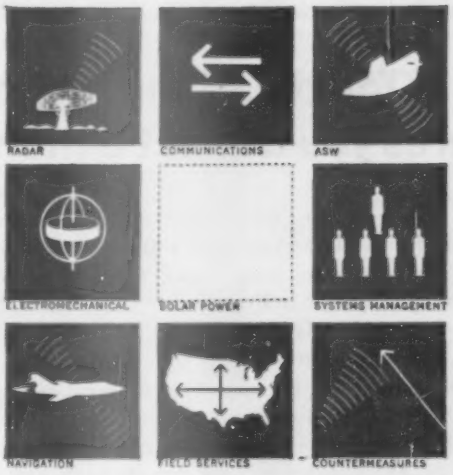

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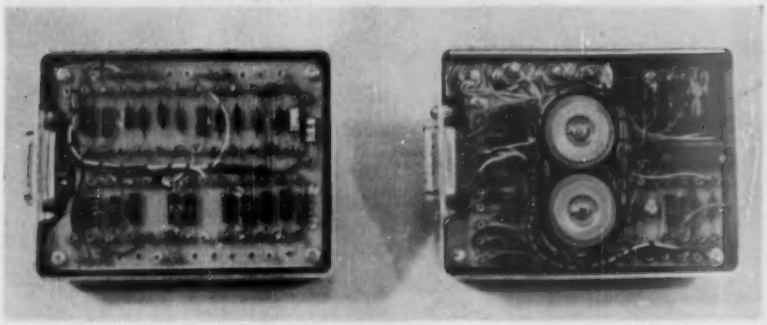


MAGNETIC pre-amplifier and power amplifier form the control box for the modular control systems. The contactorless controls include both magnetic and transistorized amplifiers.

Modular Electromechanical Units Cut Costs, Engineering Lead Time

Reductions in cost and engineering lead times in aircraft and missile control system design are promised by the producers of packaged modular electromechanical control systems. The modular concept enables designers to assemble a control system from transducer to actuator with standard components.

Initial applications of the modular systems include an oil temperature control on the Grumman W2F airborne early warning aircraft and a helicopter throttle control. Airborne Accessories Corp., Hillside, N. J., says the modular system also is being evaluated for missile control applications.

The basis of the packaged systems, the modular control units, followed the development of modular actuators in 1958. These actuators, both rotary and linear, provided some design flexibility and a reduction in the need for custom engineered actuators; however, the electronic control boxes still required some degree of custom engineering.

The development of packaged modular control systems promises a reduction in this engineering. The control packages consist of standardized control boxes into which are plugged unitized pre-amplifier and power amplifier subsystems. Both magnetic and transistorized amplifiers are available in the contactorless control packages.

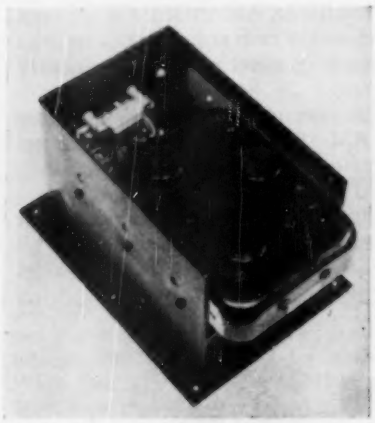
The circuitry for each subsystem is mounted in a chassis and can be quickly changed by means of quick disconnect fittings. Amplifiers drive motors ranging up to 200 watts or control any physical response in relation to a variable stimulus as sensed by the transducer.

The addition of the modular control packages completes the control system. The system incorporates a range of transducers including potentiometers, tach generators and thermistor probes, the control packages and the modular actuators.

The linear actuators have a maximum operating load of 500 lb. and the rotary actuators have a maximum load of 100 in./lb., with both dependent on the motor and gear ratio selected.

Airborne says that in addition to design flexibility, the modular control systems offer designers size and weight reductions and, in some respects, increased reliability. The modular concept will not eliminate all control system engineering problems. With only slight modification, however, the modules will provide the basis for immediately accessible systems.

The chassis operating temperature limits vary from 71C on the transistorized amplifiers (120C limit available on special order) to 125C for the magnetic amplifiers. The weight of both the transistorized and magnetic power amplifier is 1.15 lb.



MODULAR control box with transistorized power amplifier partially inserted. Module case measures 5 x 3 x 4 in.

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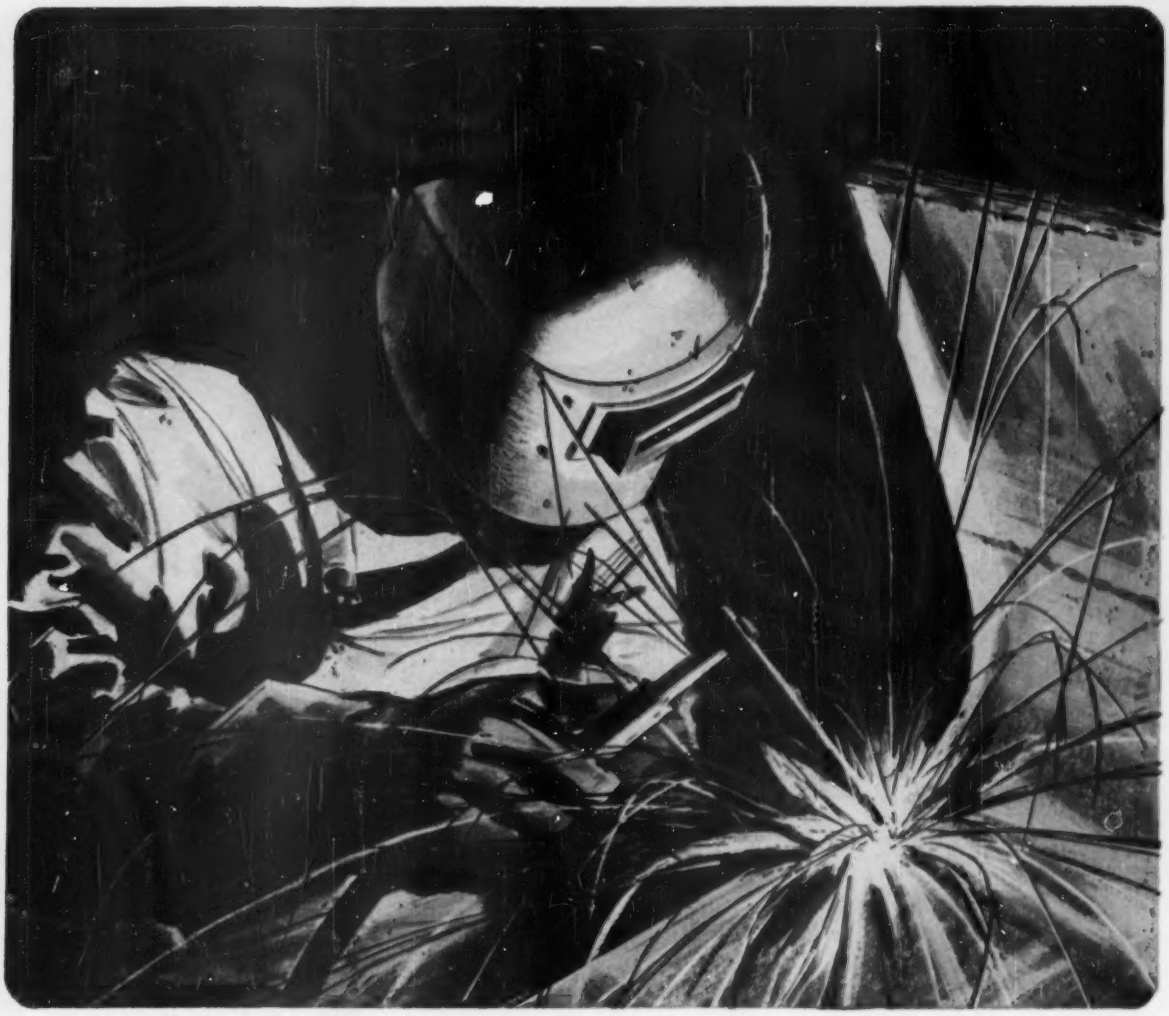

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AM 350 is available commercially in sheet, strip, foil, small bars and wire. AM 355, best suited for heavier sections, is available commercially in forgings, forging billets, plates, bars, wire, sheet and strip.

For further information, see your A-L sales engineer or write for the new technical booklet, "AM 350 and AM 355." ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*** 852

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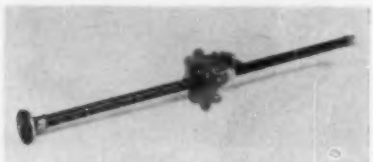
Specifications include: continuous duty four-pole, three-phase, 200 v. motor; weight, 21 oz.; amp., 0.75; pump pressure rise, 20 psi. at 2.8 gpm. The pump is 4.38 in. long and has a diameter of 2 in.

Task Corp., 1009 E. Vermont Ave., Anaheim, Calif.

Fuel Tank Sight Gage

Slip tube gage is designed to provide fast and accurate determination of the amount of fuel in aircraft wing and fuselage tanks.

Model 500100, "BLIP" (by light internal piping) gage consists of a housing which is bolted to the inside of the fuel

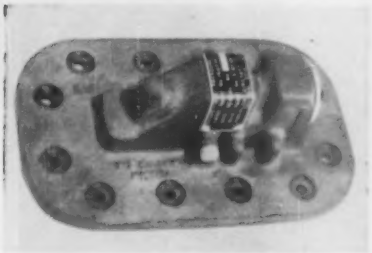


tank, and a slip tube which passes through the housing into the tank. When the end of the tube is above the fluid level in the tank incident light causes the inside of the tube to light up. When the tube is withdrawn the tube darkens as its upper end becomes immersed in the fluid. At this point the reading is taken. The gage is available with scales indicating U. S. gallons, Imperial gallons or pounds and may be calibrated with any aircraft fuel tank.

Sierra-Schroeder Controls Division, 4310 San Fernando Rd., Glendale 4, Calif.

Pneumatic Bleed Valve

Air pressure bleed valve meters a constant 50 cfm. air supply at 50 psi. to the control system of an intercontinental ballistic missile. Variations of



the valve for other fluids, pressures and control rates are feasible.

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- **FLIGHT DATA COMPONENTS** Analysis proposal, design and development work in the following specialties: circuit analysis, servo theory, transducers, transistors, airborne instrument and analog development of high and low temperature problems.
- **ELECTROMAGNETIC DEVELOPMENT** Work with magnetic amplifiers requires knowledge of electromagnetic theory, materials and design methods.
- **INSTRUMENT DESIGN** Electromechanical design of force-balance instruments, pressure measuring devices, precision gear trains and servo-driven positioning devices. Experience in electrical and electromagnetic transducers desirable.
- **AIRBORNE INSTRUMENTATION ANALYSIS AND DESIGN** Work involves solving problems in accuracy, response and environmental effects.

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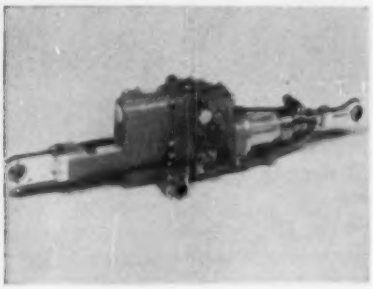
mits mounting to the outer shell of the missile with only the sliding lever exposed. Valve body and closure are of HK31 magnesium alloy; seal is of silicone rubber. The complete assembly weighs 0.62 lb.

Koehler Aircraft Products Co., 409 Leo St., Dayton, Ohio.

Feedback Servoactuator

Electrohydraulic servoactuators for missile and space vehicle controls employ a mechanical feedback eliminating electrical transducer and amplifier.

Feedback of the piston position to the armature of the input force motor is accomplished by springs together with



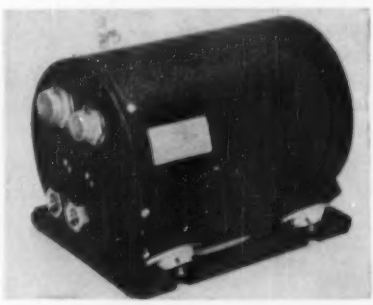
a precision motion reductive device. Design parameters available include piston areas to 3 sq. in. and strokes to 4 in. Auxiliary components, such as telemetry potentiometers, force or velocity limiters, and shut-off solenoid valves, may be included as integral assemblies.

Moog Servocontrols, Inc., E. Aurora, N. Y.

True Airspeed Computer

Miniature true airspeed computer consists of a force balance Mach transducer, a passive resistance network and a follow-up servo.

The Minitas computer is a minaturized version of larger TAS computers, weighing 6.5 lb., measuring 5



in. in diameter by 8¼ in. long and conforms to MIL-E-5400 and 5272. Three operating ranges can be supplied to satisfy the requirements of aircraft and missiles with airspeeds from 70 to 1,500 kt.

Servomechanisms, Inc., 12500 Aviation Blvd., Hawthorne, Calif.

WHAT'S NEW

Reports Available:

Symposium on Particle Size Measurement—American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. In addition to the 18 papers presented, a list of ASTM standards pertaining to particle size measurement is included. $6.25; 308 pp., hard cover.

Resiweld Epoxy—H. B. Fuller Company, 255 Eagle Street, St. Paul 2, Minn. A new booklet on Resiweld Epoxy Adhesives, Sealants, Alloys and Coatings, including a product description and technical bulletin on the standard line of products. No charge.

Tech Notes From Allied—A new technical news letter which will feature developments in the field of electroforming. Allied Research & Engineering Division, Allied Record Manufacturing Co., 6916 Santa Monica Blvd., Los Angeles 38, Calif.

Plastics Safety Handbook—By the Society of the Plastics Industry, Inc., 250 Park Avenue, New York 17, N. Y. $5.00 plus postage; 200 pp. Published in cooperation with the National Safety Council, devoted to safety in the plastics processing industry.

Publications Received:

Jet Propulsion Engines – By O. E. Lancaster – Princeton University Press, Princeton, N. J. $20.00: 799 pp. Analyses of various forms of jet propulsion engines, including turboprops, turbojets and hybrid types with sections devoted to the historical background and use of atomic energy in jet propulsion.

Basic Research in the Navy—Arthur D. Little, Inc., for Offices of Naval Research. June, 1959. $7.00; 2 volumes—189 pp. (PB 151925).

Vision in Military Aviation—Institute for Applied Experimental Psychology—Jackson & Moreland, Engineers for Wright Air Development Center. Nov., 1958. $5.00; 394 pp. (PB 151653).

Summary of Instrumentation Development and Aerodynamic Research in a Hypersonic Shock Tunnel—Part II: Nozzle Flow Study and Flow Angularity Measurements—by E. E. Wittliff and M. R. Wilson, Cornell Aeronautical Laboratory, Inc., for Wright Air Development Center, U. S. Air Force. Dec. 1958. $.75; 27 pp. (PB 151742).

Supersonic Wind-Tunnel Tests of Ring-Wing Configurations—L. H. Schindel, Massachusetts Institute of Technology for WADC. Dec., 1958. $2.50; 108 pp. (PB 151754).

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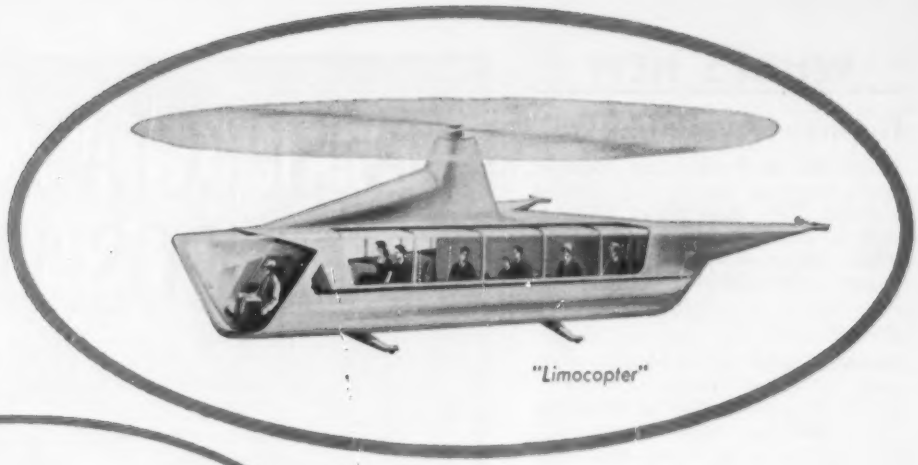

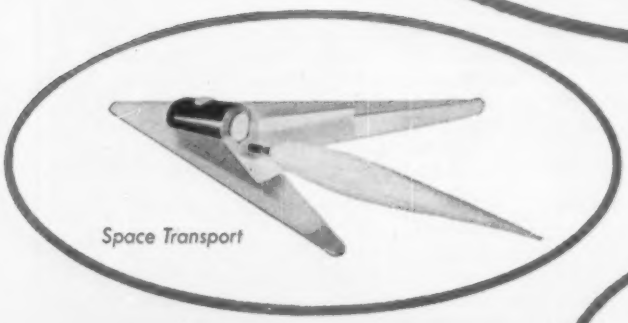

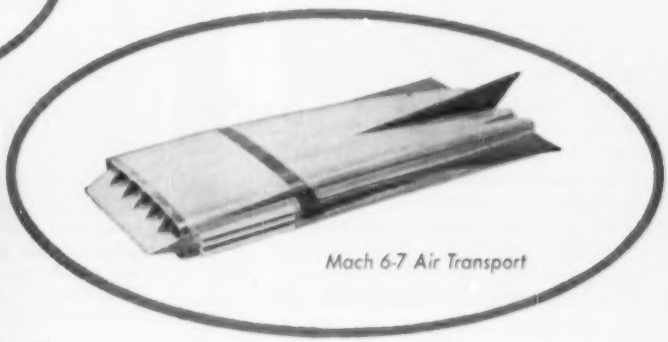

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LOCKHEED / CALIFORNIA DIVISION

WHO'S WHERE

(Continued from page 15)

Changes

Dr. Walter Appleman has joined the staff of Convair (Astronautics) Division of General Dynamics Corp., San Diego, Calif., as a staff physician and consultant to engineering groups on space medicine problems in manning of space vehicles and satellites. Also: **Gene L. Armstrong**, senior project engineer for airborne systems-Atlas program.

A. N. Ballard, factory manager, Summers Gyroscope Co., Santa Monica, Calif.

Kermith F. Wasmuth, director of Martin-Denver's Quality Control Division, succeeding **H. P. Campbell**, now manager of the Quality Control Department, Electronic Division.

Edward F. Spraitz, assistant Washington, D. C., representative for space programs for Douglas Aircraft Co.

Dr. Raymond R. Bouche, manager, Standards and Analysis Department, Endevco Corp., Pasadena, Calif.

Frederick C. Durant, III, director of public and government relations, and **E. Douglas Kenna, Jr.**, director of marketing, Avco Corp.'s Research and Advanced Development Division, Wilmington, Mass.

Joseph Oppenheim, programs manager, Missile Systems Division, Raytheon Co., Waltham, Mass.

General Electric's Small Aircraft Engine Department, Lynn, Mass., has announced the appointment of the following engine program managers: **D. C. Gerry**—T58 project; **E. Woll**—T64 project; **F. O. MacFee**—J85 project; **J. N. Krebs**—CF700 project. Other managerial appointments in the department: **H. T. Hokanson**—design and development engineering; **T. W. Shidler**—marketing; **K. N. Bush**—manufacturing; **L. I. Asher**—finance; **E. O. Hendrickson**—customer service; **L. R. Heurlin**—evaluation and systems analysis; **R. L. Miles**—relations and utilities.

John M. Van Dam, general manager, Western Division of Aeroquip Corp., Burbank, Calif. Also: **M. Lloyd Jones, Jr.**, general manager, General Logistics Division, Burbank, Calif.; **Victor Emery**, general sales manager, Industrial Division, Jackson, Mich.

Martin Dubilier, general manager, International Electric Corp., Paramus, N. J., a division of International Telephone & Telegraph Corp.

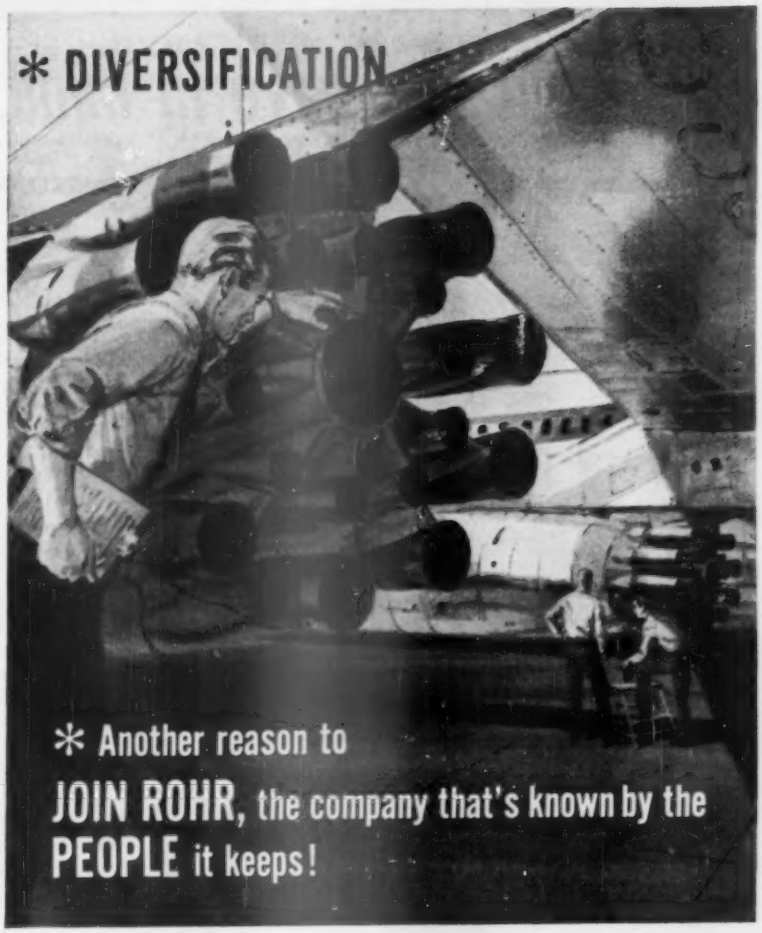
Robert G. Schlenzig, product manager of Gyro Programs, AC Spark Plug Division of General Motors Corp., Milwaukee, Wis.

Dr. M. John Rice, Jr., manager of semiconductor material engineering, CBS Electronics Division of Columbia Broadcasting System, Inc., Danvers, Mass.

William C. Benson, manager-ground support equipment sales, Solar Aircraft Co., San Diego, Calif. Also: **Rex Welch**, manager-sales, Electronic Systems Development Corp., Ventura, Calif., a subsidiary of Solar.

Irving P. Magasiny, director of engineering, Schaevitz Engineering, Pennsauken, N. J.

Herbert K. Krumel, staff assistant to the vice president and general manager of Fruehauf Trailer Co.'s Missile Products Division, Los Angeles, Calif.



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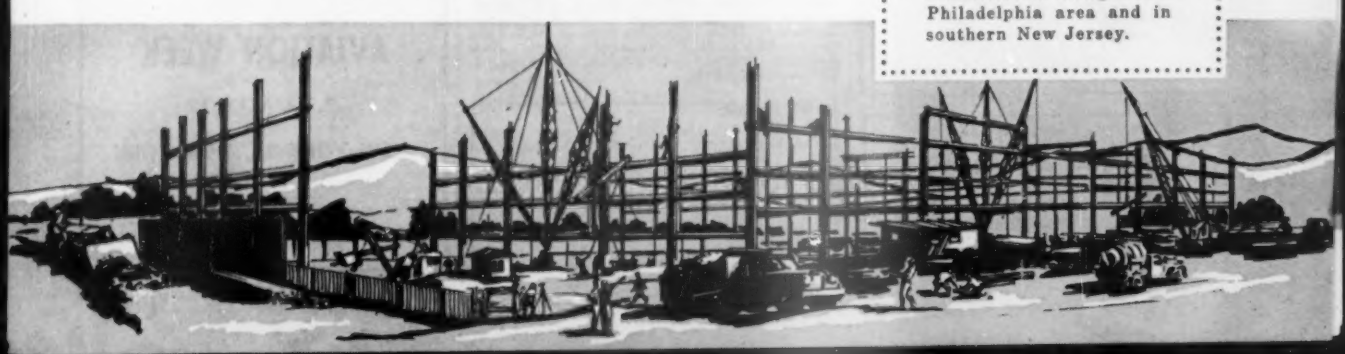

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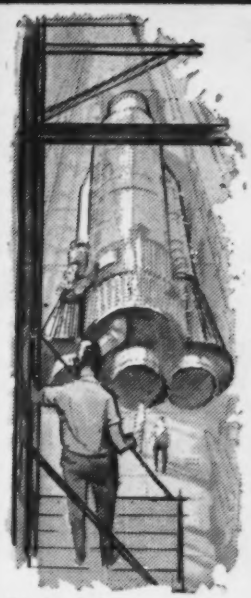

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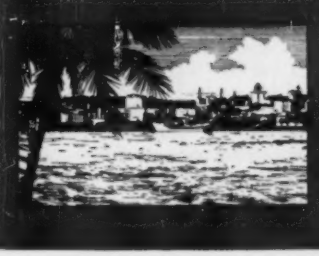


LETTERS

B-70 Editorial

I read with deep interest and appreciation your excellent editorial, "A Dangerous Decision" (AW Dec. 7, p. 21), concerning the reorientation of the B-70 development into a prototype program.

You are quite right in your analysis that the importance of developing a Mach 3 aircraft means much more to the country than the economic effects on our company and the thousands of subcontractors participating in the program.

Since North American won the Air Force competition to develop the B-70, we have been keenly aware of our great responsibility to push forward as rapidly as possible the development of this system as a vital element in maintaining our nation's air supremacy. We are continuing our efforts with equal vigor in the prototype program, which we sincerely hope will be carried on into the operational phase.

Your thoughtful comments in this regard are a great help toward reminding many people of the continued need for high performance manned vehicles as part of the national defense posture.

J. L. Atwood, President
North American Aviation, Inc.
Los Angeles, Calif.

(The following editorial appeared in the Washington Post Dec. 11, four days after Aviation Week's editorial of Dec. 7 on the B-70 entitled "A Dangerous Decision." —Ed.)

"The Great Bomber Gamble"

"The recent Administration decision all but to abandon the B-70 bomber program is a dangerous gamble. The Air Force had looked to the 2,000-mile-an-hour B-70 to extend strategic deterrence by manned bombers through the period three to six years hence when Soviet air defenses will in all likelihood have rendered the subsonic bomber fleet obsolete, even as they have already greatly diminished its deterrent effect.

"Not for several years is this country likely to be able to place its chief reliance on missiles to deter an attack, and even then manned aircraft may have reconnaissance and other essential roles. The present intention to hold down Atlas missile production, though in part simply a budgetary decision, also indicates that the focus of the missile program has shifted from this and other first-generation rockets to the more promising solid-fueled Minuteman and Polaris programs. These latter will not be available in strategically significant numbers for perhaps five to seven years. Thus the period for which the B-70 was programmed may be a period of extreme peril for this country, a period when Soviet missiles would have no counterpart here either in bombers capable of penetrating modern defenses or in reliable, accurate missiles of sufficient invulnerability.

"The official rationale is that subsonic bombers equipped with air-to-ground missiles like the Hound Dog and on an "air alert" can fill this gap, along with some initial Polaris capacity and the highly vulnerable Atlas, Thor and Jupiter missiles now being produced or already deployed. The supersonic B-58, slower than the B-70, is also counted upon, but it, too, has been lately starved for funds. Not yet operational, the B-58 may come too late. Such weapons will, to be sure, constitute a measure of deterrence, for even the most successful enemy strike would be unlikely to knock out all American retaliatory capacity, and some penetration of Soviet defenses might be achieved.

"But an enemy's decision on the risks of such an adventure cannot possibly be predicted with much accuracy or confidence. The American posture must be overwhelmingly secure if diplomacy is to have the room for maneuver needed. The B-70 could add significantly to strategic striking power. If the arbitrarily limited defense budgets which the Administration is projecting are not big enough to incorporate programs of this urgency, the ceilings ought to be raised —and with them whatever new revenues may be required."

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Thank you—thank you—thank you for the magnificent editorial "A Dangerous Decision" appearing in the Dec. 7 issue of Aviation Week. How apropos that you should remind us—on Dec. 7th—of the magnitude of awareness, the catastrophic results of unpreparedness. The cancellation of the B-70 program (and that is precisely what this decision amounts to) shall probably be regarded in history as one of the most tragic "ostrich-head in the sand" decisions of our time. To completely ignore the technical gap in our strategic deterrent force is to invite disaster. Without sufficient reconnaissance or follow up strike capabilities, there will be no one left to push the buttons that launch our missile force into action.

Congratulations.

Mrs. Marcia L. Kroeker
Aerol Associates
Wichita, Kan.

After reading your editorial of Dec. 7, I am convinced that my long-standing opinion of you is correct. You are without a doubt one of the most narrow-minded editors I have ever heard of. I knew exactly what this editorial would say before I ever received the magazine.

Your outstanding characteristic is that you can only see one side of the question—the side your bread is buttered on. You cannot see any further than your magazine and the aviation industry. You are against any kind of a cutback in the aviation industry—regardless! And with this in mind you write editorials! You would have the country bankrupt, but you would have your B-70s and every other program technology could devise.

The fact that the B-70 is a marginal airplane with a limited potential is of no consequence. If each airplane were to cost $500 million instead of $50 million, your plea would be the same. And your thinking is the same for space stations, moon bases, or even Mach 50 helicopters, if technology proved them feasible.

You may think I can say this because I'm not affected. But I am an engineer for a company which had a B-70 subcontract, so I have more to lose than you have.

Mr. Hotz, it's time you faced the facts of economics, and get out of your aerospace dream world. Use a little discretion. As it is, you are as easy to see through as a plate glass window.

As it is, your editorials are the weakest part of your magazine.

Anonymous Engineer
Atlanta, Ga.

Limited Vision

In response to your series of editorials written by Robert Hotz concerning the financial starvation of our "space program," the cancellation of the F-108, and now the more recent cuts in the development program of the B-70, I wish to state, as a representative of the class of 1961, that we could understand the cancellation of the Regulus II and the Rascal because of their relative obsolescence. We can conceive the necessity to draw the line on the F-107. We will accept the apologies given for the failure to support project "Orbitor." We were puzzled by the failure of the present Administration to back the nuclear aircraft program with more substantial aid, and by the failure to exploit the boron fuel derivatives. We were alarmed by the cancellation of the F-108, and now we are extremely apprehensive with the present B-70 budget slash.

I, for one, believe that it is extremely unfair and a grave injustice that we will be expected to regain—if the peace lasts that long—the air and space supremacy of 1975, which is being lost today by men with tight purse strings and limited vision.

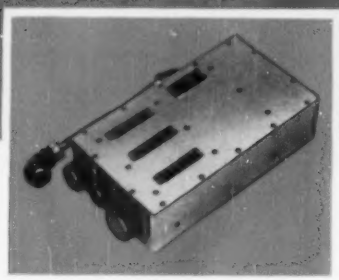
Earl R. Towson
Aeronautical Engineer Major
California State Polytechnic
San Luis Obispo, Calif.

Clear Exposition

Your article, "Automation Cuts Zeus Transistor Costs" (AW Nov. 30, p. 74), is a monumental work. Seldom has there appeared in up-to-date literature such a clear and comprehensive exposition of a complex project in the modern technology.

Thomas J. Harriman
Vice President
Director of Engineering
Giannini Controls Corp.
Pasadena, Calif.

Another example of LFE capability in airborne electronics



LFE Magnetic Amplifier controls frequency and load division between alternators. It is employed in the power supply systems of both the X-15 and B-52.

How LFE *helped solve power control problems for the X-15*

When the X-15 zooms to the outer fringes of the atmosphere where there is inadequate natural combustion, two auxiliary systems . . . fueled by hydrogen peroxide . . . become the sole source of power.

Electricity and hydraulic pressure produced by this 48 lb. package power the space vehicle's complete instrumentation, air conditioning, communications, guidance and operating control systems . . . from launch to touchdown.

LFE designed a Magnetic Control Amplifier that maintains constant power supply frequency despite radical variations in load and temperature extremes. Acting as a servo-controller this compact solid state device controls flow of hydrogen peroxide to the turbine and constantly correct frequency error and load unbalance. The degree of control achieved ($\pm 0.5\%$) represents the ultimate in the present state of the art.

The reliability of the basic design has been proven in production, by LFE, of several thousand Magnetic Amplifier Controllers for the B-52. From proposal — to prototype — to production, the performance of the servo-controller dramatically exemplifies LFE's capability for meeting new problems with new concepts.

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